OCTOBER 26, 1959

STEEL
The Metalworking Weekly

A PENTON PUBLICATION

Meta Selec

1959 EDITION

Edited for today's busy metalworking ma
Selector is the most comprehensive single
and alloys available anywhere. In previo
lished in 1955) we covered standard me
next. This year, the editors have comb
booklet.

It is designed to help you pick the righ

- It covers 20 categories of ferrous an alloy steels to zirconium.
- In all, there are 1050 product listings.
- Compositions and applications are of the material you need.

named to help you
als a

METAL SHOW SECTION

On Page 145, you'll find the most comprehensive single source of information on metals and alloys available anywhere. It's STEEL's 1959 Metal Selector—listing 1050 products with their producers, compositions, and applications. Other special features in the section include the program for the 1959 Metal Show, Page 185.

Next Big Battle in the Steel Case: The Fight for the Worker's Minds

Are We Facing a Manpower Shortage?

Aluminum: A Young Giant in Housing

Ablation: Answer to Re-entry Problem

Are 1 Million psi Steels Possible?

Firms of Three Nations Join Hands To Push Strategic-Udy Process

COMPLETE CONTENTS
TURN PAGE

METALWORKING OUTLOOK
PAGE 83

FIRST 2 OXYGEN CONVERTER INSTALLATIONS IN THE UNITED STATES EC&M CONTROLLED!

for basic steel making... it's EC&M CONTROL

EC&M control has proved itself by years of consistent performance in basic steel making processes —ore handling, hearth charging, ladle cranes, hot metal mixers, Bessemer converters.

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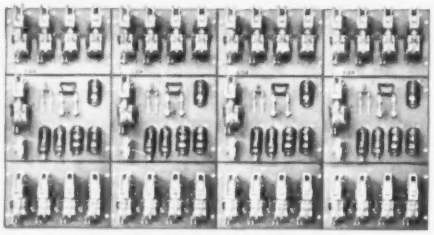
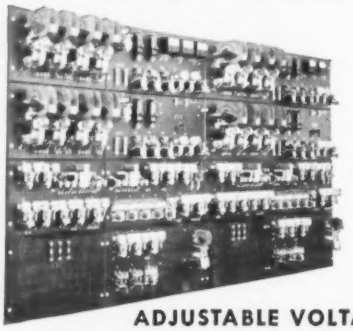
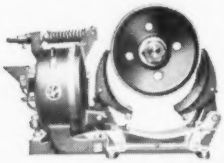


CONSTANT POTENTIAL

1. Speed Control Master Switch



ADJUSTABLE VOLTAGE



2. Dual-Coil Series or Shunt Wound Brakes

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A DIVISION OF THE SQUARE D COMPANY

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This Week in STEEL

The Metalworking Weekly

October 26, 1959 Vol. 145—No. 17

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STEEL, the metalworking weekly, is selectively distributed without charge to qualified management personnel with administrative, production, engineering, or purchasing functions in U. S. metalworking plants employing 20 or more. Those unable to qualify, or those wishing home delivered copies, may purchase copies at these rates: U. S. and possessions and Canada, $10 a year; all other countries, $20 a year; single copies, 50 cents. Metalworking Yearbook issue, $2. Published every Monday and copyright 1959 by The Penton Publishing Co., Penton Bldg., Cleveland 13, Ohio. Accepted as controlled circulation publication at Cleveland, Ohio.

Metalworking Pulse ▶

TURN

Metalworking Pulse

INDUSTRIAL PRODUCTION INDEX

	WEEK ENDED OCT. 17	PREVIOUS WEEK	MONTH AGO	YEAR AGO
(1947-49=100) Based on steel output, electric power output, freight carloadings, auto assemblies	118† †Preliminary.	118	111	142

With the renewal of steel production, the economy should show signs of a slow uptrend before too long, although some indicators will get worse before they get better. STEEL's index will start moving up for the week ended Oct. 24.

Details on Page 113

U. S. PASSENGER CAR PRODUCTION

	WEEK ENDED OCT. 24	PREVIOUS WEEK	MONTH AGO	YEAR AGO
Number of units assembled ..... (Source: Ward's Automotive Reports.)	130,000* *Estimated.	135,312† †Preliminary.	91,341	70,973

Production of passenger cars in the week ended Oct. 17 marked the high point until steel supplies become more plentiful. That may not be until mid-November. Chevrolet has been hardest hit so far.

Details on Page 111

NATIONAL STEEL INGOT PRODUCTION

	WEEK ENDED OCT. 25	PREVIOUS WEEK	MONTH AGO	YEAR AGO
Net tons (thousands)	368*	368	362	2,026
Index (1947-49=100)	22.9*	22.9	22.5	126.1
Percentage of capacity	13.0*	13.0	12.8	75.1

*Estimated by STEEL; comparative figures reported by AISI.

A large portion of increased ingot production immediately following reopening of mills will be derived from electric furnaces. Other types of steelmaking furnaces will require a longer period to attain a high operating rate.

Details on Page 240

STEEL SCRAP PRICE COMPOSITE

	OCT. 21	WEEK AGO	MONTH AGO	YEAR AGO
Based on No. 1 heavy melting grade at Pittsburgh	$44.33	$44.33	$41.00	$42.33

A strong upward price trend is expected to get underway shortly after return of workers to the mills. Some dealers predict an early rise of $3 or more a ton on No. 1 grades of steelmaking scrap.

Details on Page 252

FINISHED STEEL PRICE INDEX

	OCT. 20	WEEK AGO	MONTH AGO	YEAR AGO
Based on Bureau of Labor Statistics data (1947-49=100)	186.8	186.8	186.8	186.2

Steel producers are maintaining firm price schedules pending clarification of cost prospects. Provisions of the next labor contract may determine what action, if any, is required.

Details on Page 241

When you place an order with us, you can do so with complete confidence that your specifications on size, shape, hardness, and finish will be met in full. Moreover, you can count on good deliveries. Call us whenever you need rolls for cold-rolling steel sheet, strip, and tinplate, as well as non-ferrous metals.

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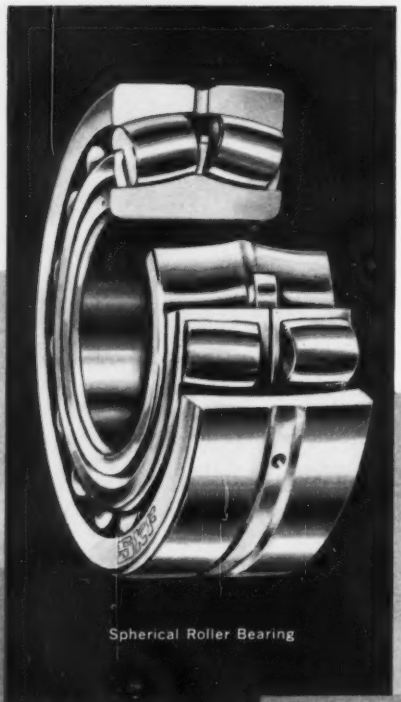
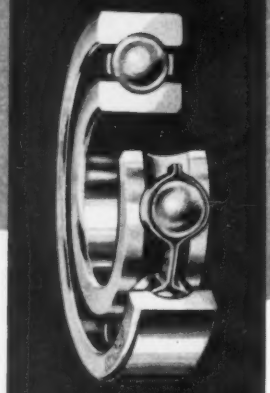


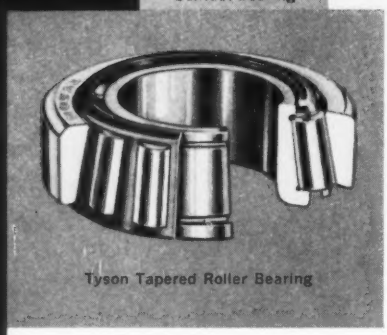
Spherical Roller Bearing

Angular Contact Bearing

Spherical Roller Thrust Bearing



Single Row Deep Groove Bearing



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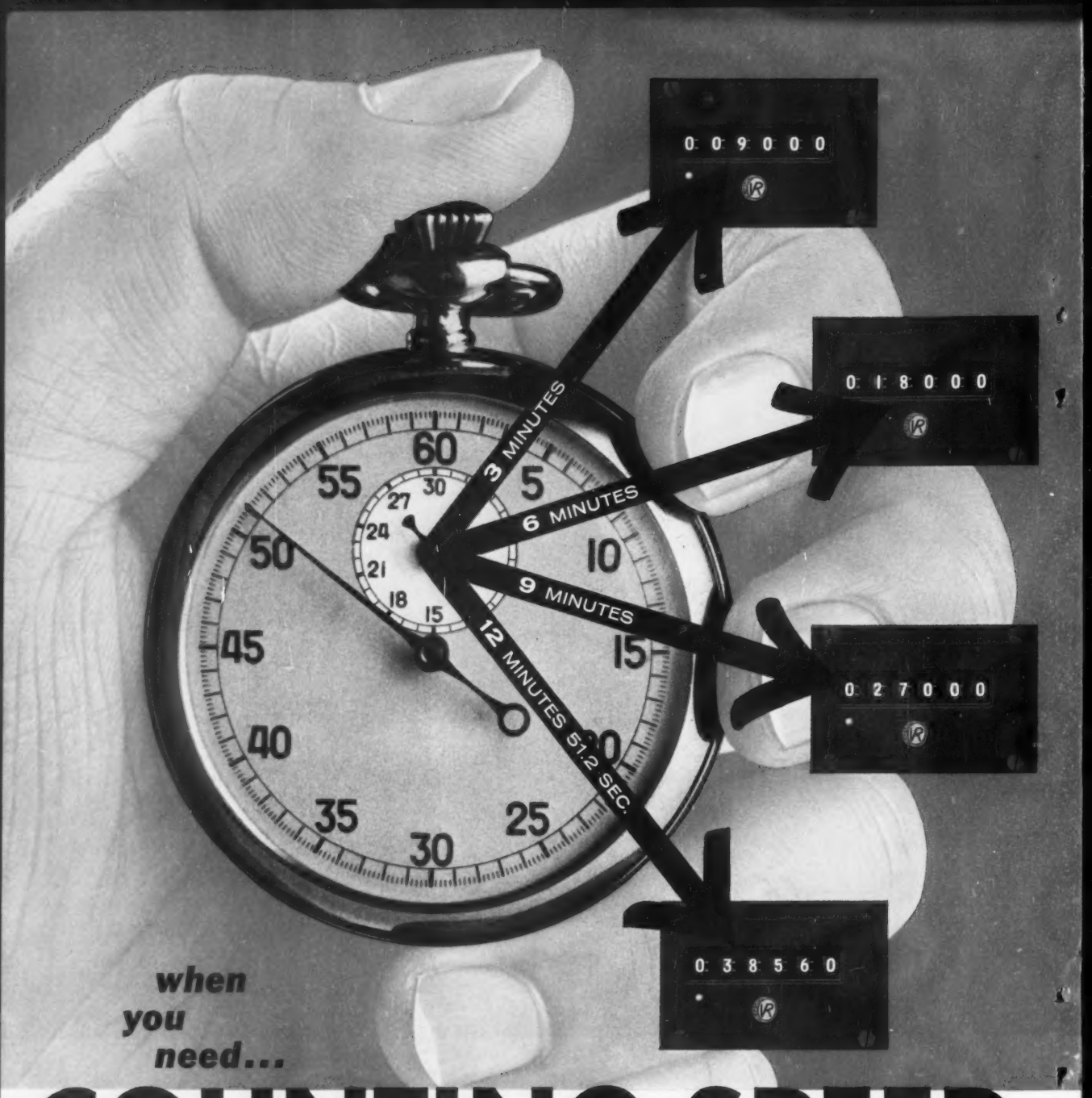

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Choogoon and Stahl

That's Ed Service's Russian for "cast iron and steel." The uniformed gent with the engrossed look has found an easy way to bridge the gaps in translating Russian to English and English to Russian. He's perusing the *Concise Iron & Steel Dictionary on the Continuous Casting Process*, the pocket sized work prepared by the British Iron & Steel Federation. The lexicon presents a brief history of continuous casting, with maps, diagrams, and pronounciation tips for Russian technical terms. You can get one by writing to Steel House, Tothill St., Westminster, London, S.W. 1, England.

Our Russian language authority, John Teresko, reviewed and approved the work. He says the Russians have latched onto some of our technical words (pyrometer becomes *piromyetr*).

Now all we need are the plans for the Russian moon rocket.

'Good for Them' Department

United Steelworker president, David J. McDonald, was interviewed in New York about the morale of steel strikers. A news service's wire story, which ran in the city edition of a metropolitan newspaper, misquoted him as declaring:

"Reports from the directors who have been close to the men back home during this time indicate a remarkable degree of high morals, unity, and determination among our people."

Combining Business and . . .

. . . pleasure is the happy state of STEEL's Detroit Editor Don Postma. He writes: "For the last two months I've been on the new car preview circuit. This annual exposure to Detroit iron tends to leave me weak in the knees, head, and, this year, in the pocketbook. I'm in the market for a car. Theoretically, I'm in one of the most enviable spots a car buyer can be in. I have access to all models. I can dig into their design, engineering, and styling. The production boys give me a steer on quality. Think this helps? Nope! It just confuses me."

Don goes on to say that he won't prejudice STEEL's readers by revealing the make or model of his new car—but you can bet it will be one of the new economy jobs.

Items We Like to Read

"If you have an extra copy of 'Improving Marketing,' article No. 8 in your Program for Management series, I would appreciate having one," writes M. N. Rivenberg, director, marketing research, Hamilton Watch Co., Lancaster, Pa.

"I had an opportunity to give the article a hasty reading and was so impressed with it that I'd like to study it in detail. The editors of STEEL are to be commended for their farsightedness in placing emphasis on marketing."

We Salute a Pioneer

Century old ledgers are examined by two officials of the Jones & Laughlin Steel Corp., Pittsburgh, as the company marks the 100th anniversary of an important metalworking patent. B. F. Jones III (right) vice president and secretary and grandson of the founder of J&L, and David T. Rogers, manager, cold finished bar products, leafed back in time to 1859, when Bernard Lauth was issued U. S. Patent No. 25,235 for "Improvement in the Manufacture of Iron." He proved for the first time that iron and steel could be rolled cold as well as hot.

A minor incident drew Lauth's attention to the significance of cold rolling. A workman rolling hot iron accidentally dropped his tongs and let them pass between the rolls. The tongs were ejected from the other side, deformed and useless. But Lauth observed how the tongs had a smooth, bright finish and seemed much stronger. He wrote in his patent application: "The iron after being cold rolled has more of the character of steel than of iron."

We salute him as one of the pioneers who formed the character of metalworking.

Trials of an Editor

Associate Managing Editor John Morgan recently covered the United Auto Workers' 17th Constitutional Convention at Atlantic City, N. J. Upon arriving at his home in Cleveland, John received a phone call from Stan Willis Jr., news-

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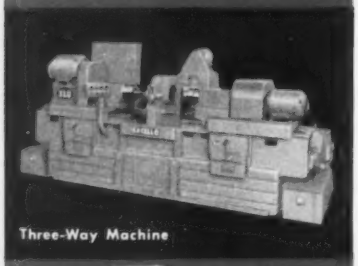
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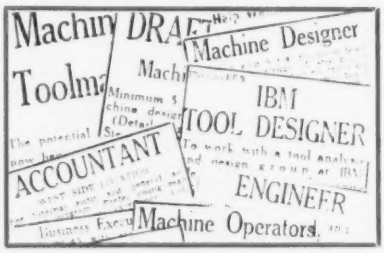
caster for station WNEW in New York. Mr. Willis asked John for comments on the steel labor situation.

There stood John, filled up to here with auto labor information and the caller wanted to talk about steel. Worst of all, John had been busy untangling his philosophy of labor, mentally rubbing off the effects of a near brainwashing by UAW chief Walter Reuther. (Mr. R. is described by John as a guy with an almost occult talent for sensing audience sentiment. He had heard the gentleman give three talks about the same labor controversy, and each time there were subtle shifts in content that altered the basic story and the effect on the audience.)

John toyed with using the "no comment" line, but his sympathy for a fellow newsman finally won out. He gave Mr. Willis a fast sketch of the steel labor picture (right out of the week's issue of STEEL) and studiously refrained from offering any news or views about the UAW. He notes: "I'd rather ask the questions any day—especially after going round and round in labor's verbal revolving door for a week."



Manpower: Shortage of the 60s

Those help wanted clippings portend a problem that will challenge metalworking managers in the soaring sixties. Thousands of jobs to be filled—managerial, technical, and skilled—but application blanks aplenty will remain blank.

Associate Editor George Howick crisscrossed the nation, traveling to metalworking centers, talking with people who are concerned about the critical dimensions of our manpower needs in the next decade.

Washington officials warned him that the U. S. faces a continuing population explosion during the sixties; but while the consuming populace will grow rapidly, the productive force will grow at a tortoiselike pace, at least until 1967.

Executives and placement people told him where and how severe the shortage will be; how you can partially offset it by better utilization of manpower; and what fields, formerly fallow, hold promise as manpower resources.

George wrapped up his interviews in four articles, the first is in this issue. The theme: The shape of a crisis—in a decade that's only 66 days away.

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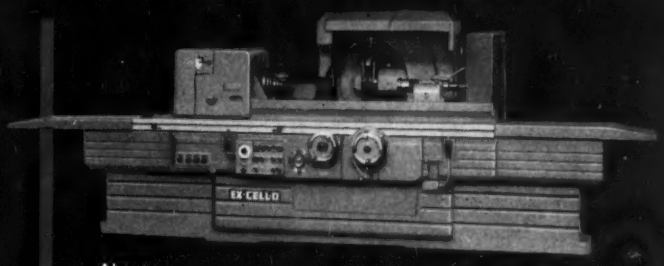
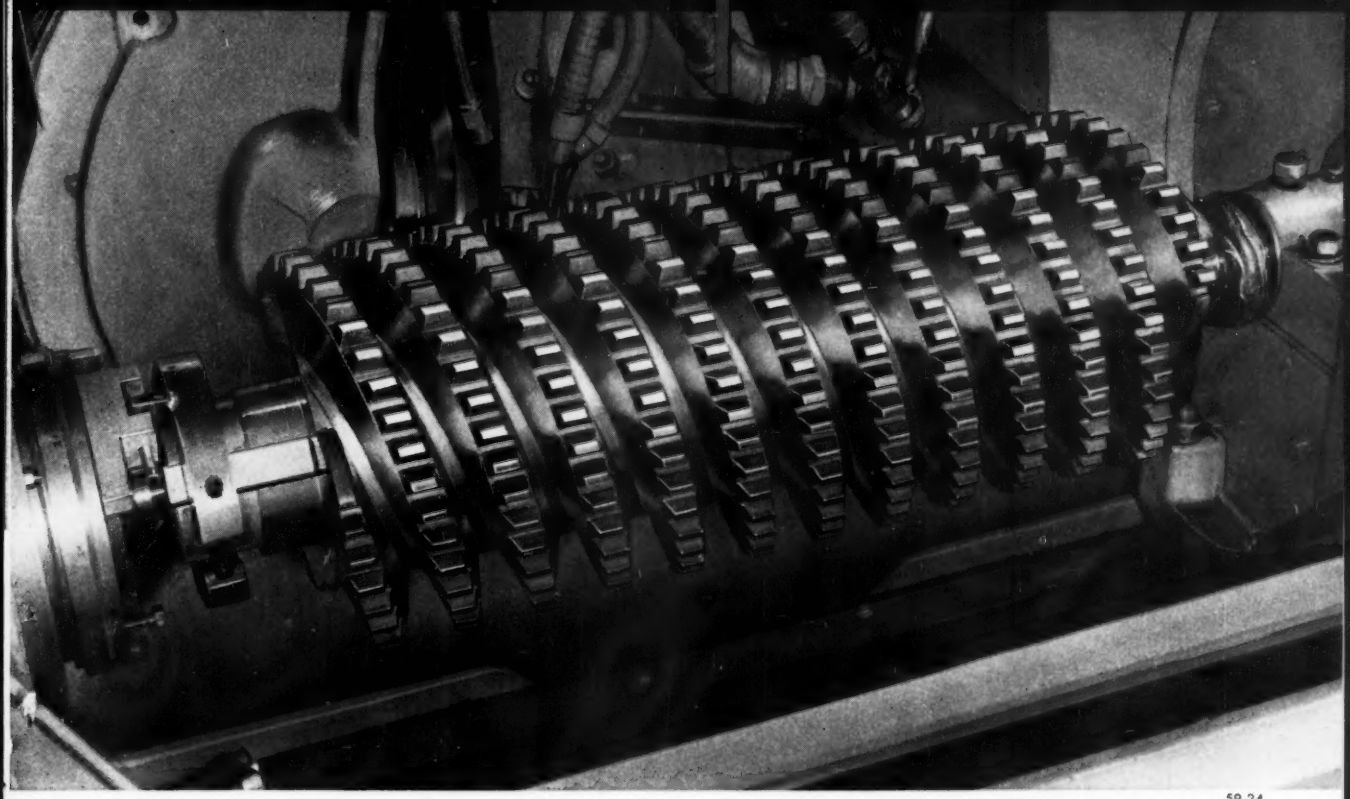


Above:
The Style 36 Precision Thread Grinder used to grind the worm gear shown above is equipped with a standard Three-Way, Cradle-Type Diamond Dresser.

Below:
Huge worm gear, shown during finish grinding, has 10" diameter. Depth of cut is 1⅜", with.170" stock removal. Thread form has included angle of 29°, a triple lead of 6°, and a specified pitch diameter of 8.0763".



59-24

A job as tough as grinding this hardened steel worm gear used by a milling machine manufacturer may not be every-day work for an Ex-Cell-O Style 36 Precision Thread Grinder—but it *can* be!

Ex-Cell-O Precision Thread Grinders combine toolroom accuracy with production output. Inbuilt flexibility makes them ideally suited to a wide range of workpiece shapes and sizes, and the popular Styles 36, 50 and 120 can be optionally equipped for precision grinding of internal threads.

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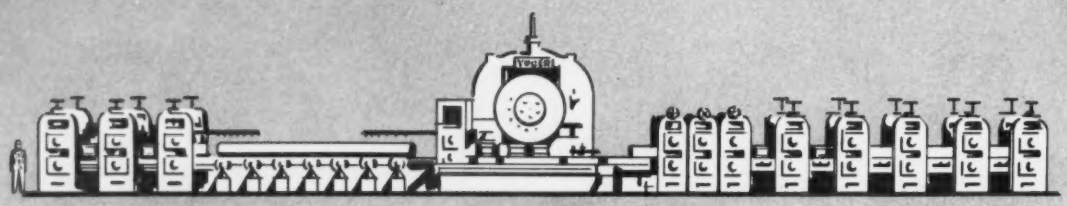
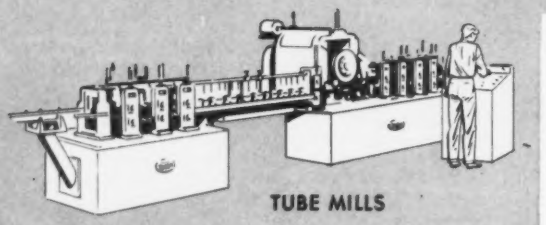
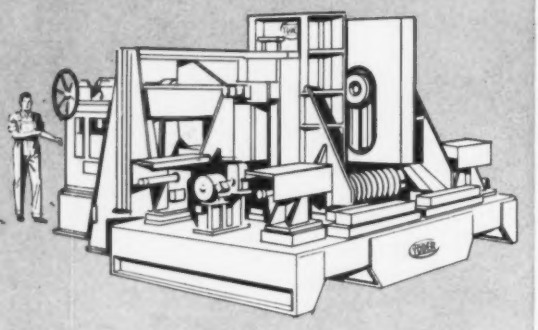


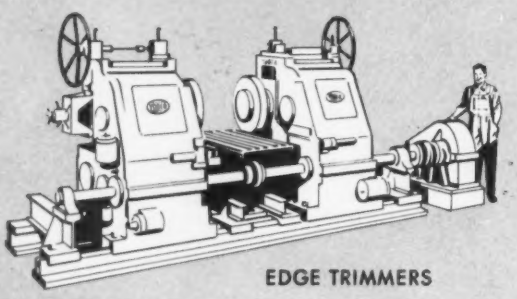
PIPE MILLS



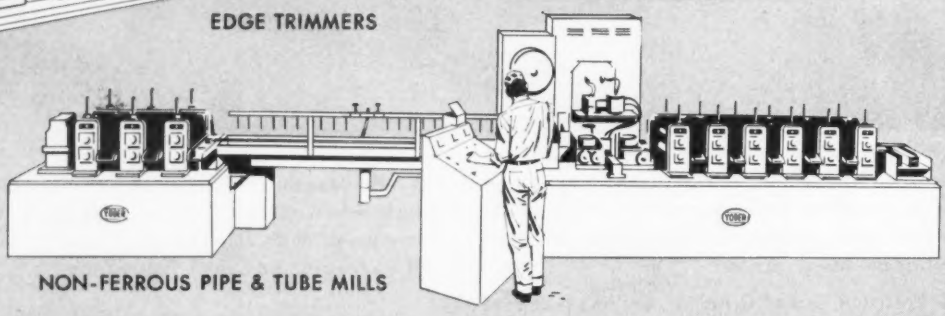
TUBE MILLS



HEAVY DUTY UNCOILERS



EDGE TRIMMERS



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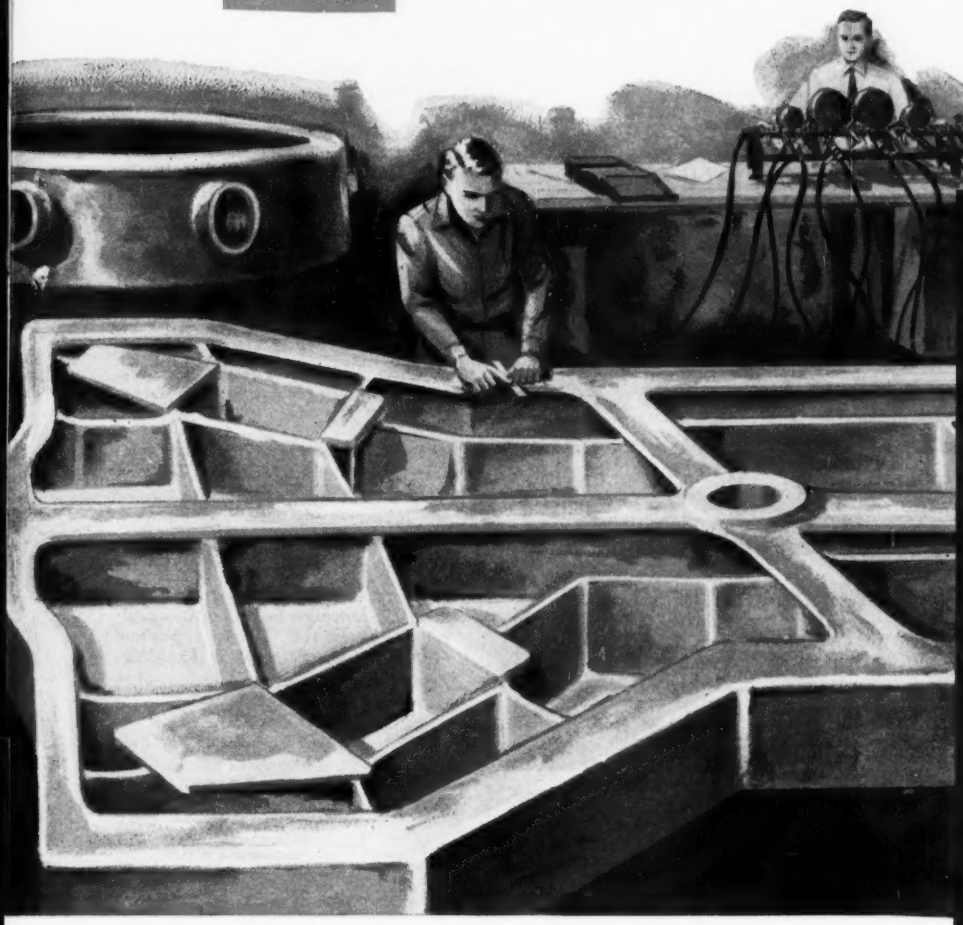
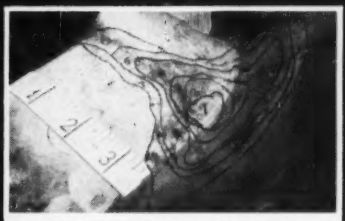




Locating high stress points with brittle lacquer.

Determining stresses with strain gages.

Dynamic testing under service conditions.

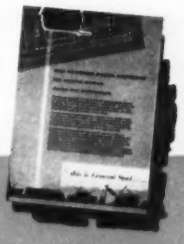
ENGINEERED TESTING...For design verification and improvement

General Steel's activities extend far beyond the manufacturing process . . . into the area of checking existing designs for product improvement, and verifying new designs.

For example, the General Steel test laboratory employs the latest stress analysis techniques and the most modern equipment to conduct brittle lacquer and strain gage analyses under controlled atmospheric conditions. Multi-directional static load tests, dynamic tests under actual service conditions, and many other types of tests are conducted to develop better cast steel structures and steel castings for use in the cast-weld and composite structures of your product.

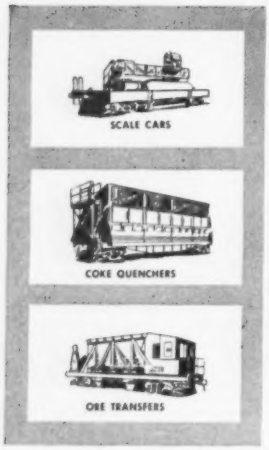
This assurance of quality from planning to performance is available to you. Let us demonstrate how you can use it . . . profitably.

Write for folder **How General Steel Castings Can Improve Product Design and Performance.** General Steel Castings, Station 230 Granite City, Illinois



GENERAL STEEL CASTINGS

GRANITE CITY, ILL. • EDDYSTONE, PA. • AVONMORE, PA.



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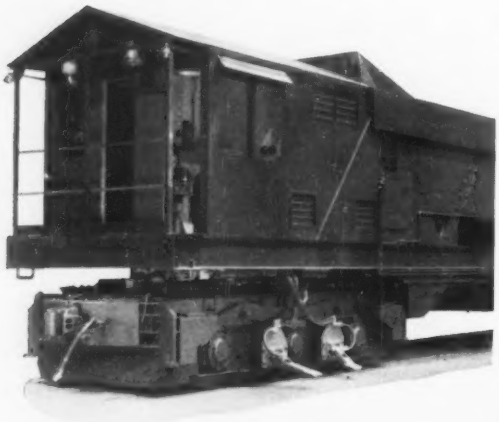

100-TON BOTTOM DUMP ORE TRANSFER

Each car Atlas builds is engineered to specific task performance . . . and designed for personnel safety.

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CAR & MFG. CO.

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Oct. 26-31, American Institute of Electrical Engineers: Fall general meeting, Pittsburgh. Institute's address: 33 W. 39th St., New York 18, N. Y. Secretary: N. S. Hibshman.

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Accent on Excellence

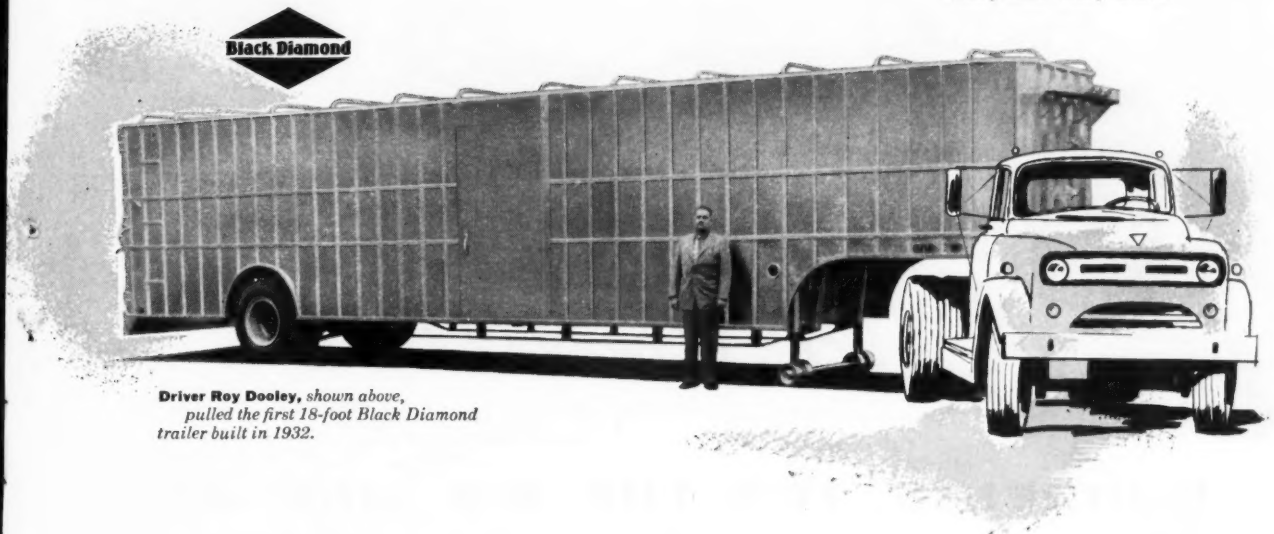
Youngstown Yoloy "E"

high-strength steel

Transport competition is rough today, so trailer vans *must* be stronger, lighter and require less maintenance if hauling operations are to show a profit.

Engineers at Black Diamond Trailer Company of Bristol, Va., report, "For almost a quarter-of-a-century, we have been custom-designing our trailer line around Youngstown Yoloy 'E' High-Strength Sheets and Plates. They save us weight, provide extra strength and give exceptionally high resistance to atmospheric corrosion. Also, Yoloy's ductility and excellent weldability help speed-up our production operations."

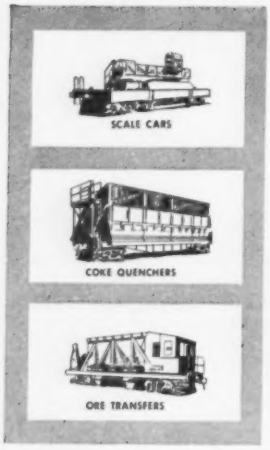
Wherever high-strength steel becomes a part of things *you* make, the high standards of Youngstown *quality*, the personal touch in Youngstown *service* will help you create products with an "accent on excellence". The Youngstown Sheet and Tube Company, Youngstown, Ohio. Carbon, Alloy and Yoloy Steel.



Driver Roy Dooley, *shown above, pulled the first 18-foot Black Diamond trailer built in 1932.*

Youngstown

Send for free technical bulletin on Youngstown Yoloy "E" Steel.



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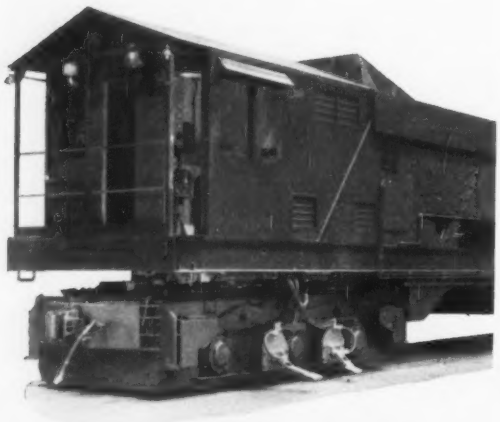

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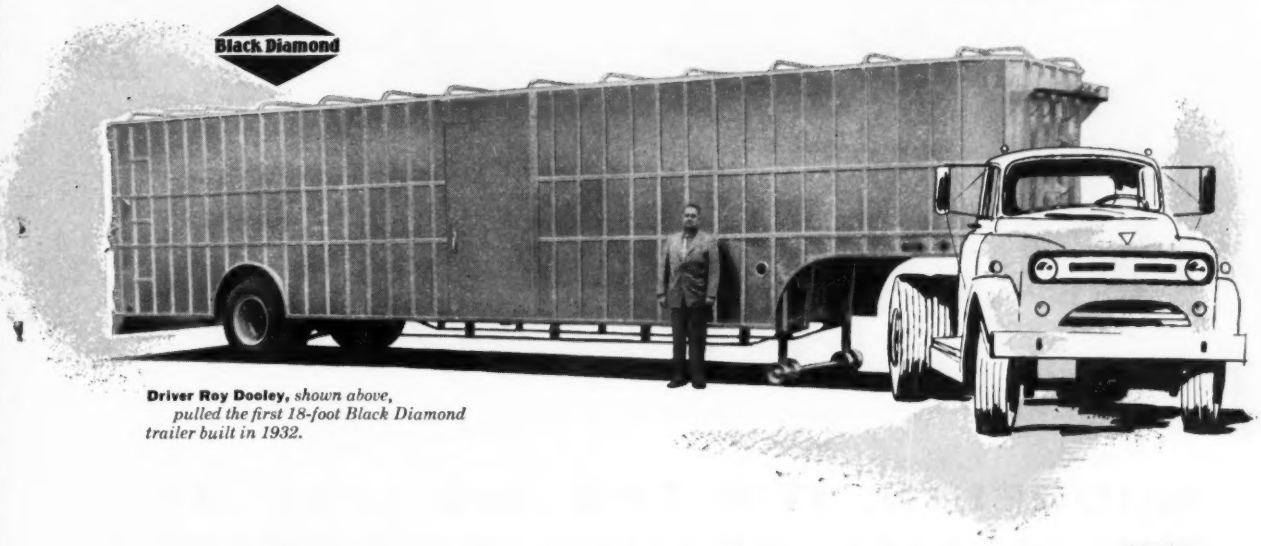

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Youngstown

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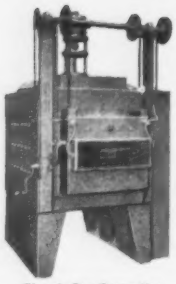
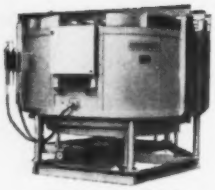


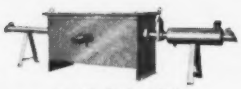
Electric Box Convection Furnace

Tool-Room Furnace with Quench



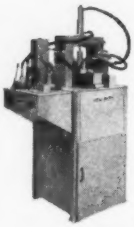
Electric Rotary Hearth Furnace

"Circ-O-Therm" Laboratory Oven



Graphite Resistor Tube Furnace

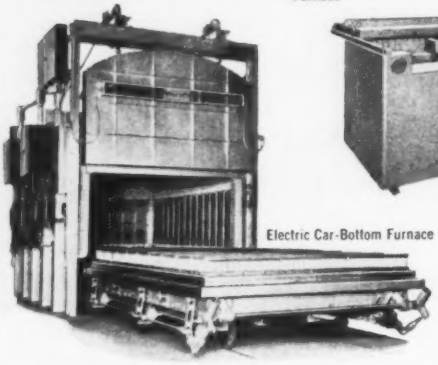
Rotating Tray Oven



Coke or Ore Testing Furnace

Electric Endothermic Atmosphere Generator

Immersed Electrode Salt Bath Furnace

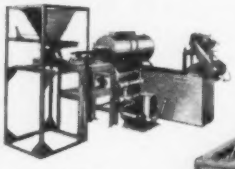


Electric Car-Bottom Furnace

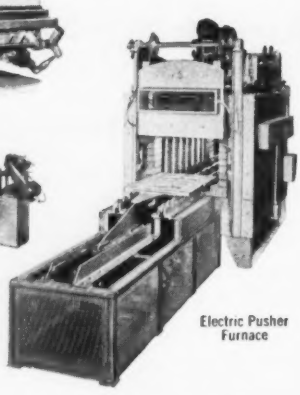
Electric Draw Furnace

Gas-Fired Endothermic Gas Generator

Gas-Fired Salt Pot Furnace



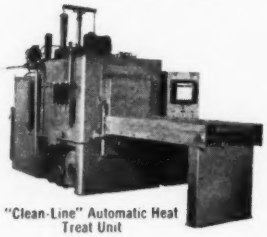
Electric Shaker Hearth Furnace



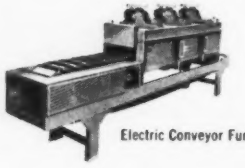
Electric Pusher Furnace

Gas-Fired Airdraw Furnace

Electric Vertical Retort Furnace



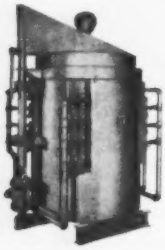
"Clean-Line" Automatic Heat Treat Unit



Electric Conveyor Furnace

Laboratory Muffle Furnace

Combustion Tube Furnace



Gas-Fired Pit Furnace

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SUDDENLY, IT'S THE BIG LINE OF INDUSTRIAL HEATING EQUIPMENT!

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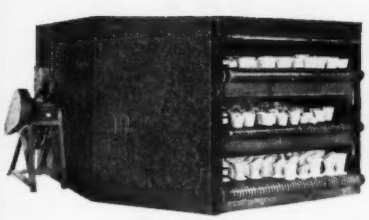
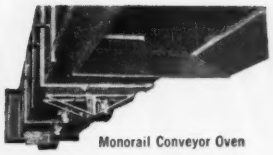
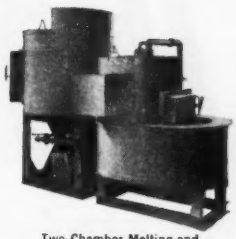
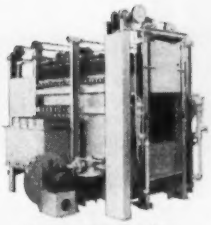
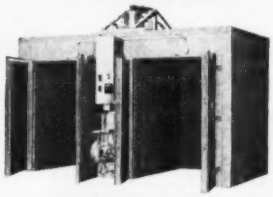
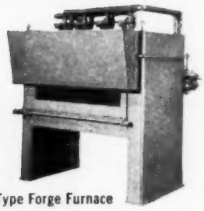

Multi-Level Belt Dryer

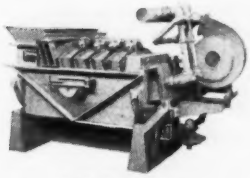

Monorail Conveyor Oven

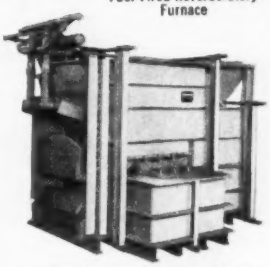

Two-Chamber Melting and Holding Furnace


Fuel-Fired Reverberatory Furnace

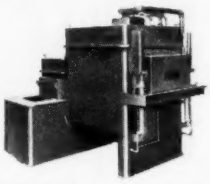

Two-Chamber, Rack-Loaded Oven


Slot Type Forge Furnace

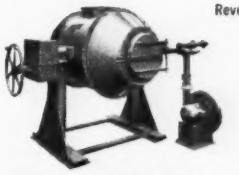

Cradle-Type Melting Furnace


Reverberatory Aluminum Melting Furnace

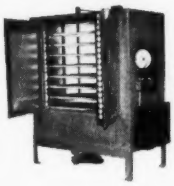
Gas-Fired Tray Loaded Oven

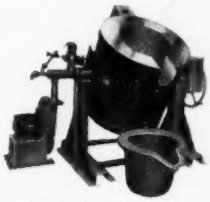

Double Chamber Dry Hearth Melting and Holding Furnace

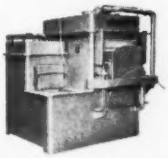
Magnesium Melting and Holding Furnace

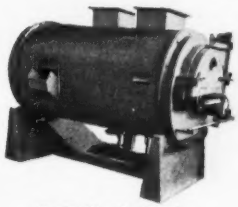

Gas-Fired Barrel Melting Furnace

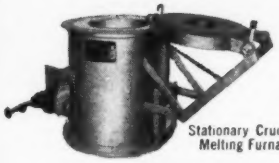
Electric Resistance Holding Furnace

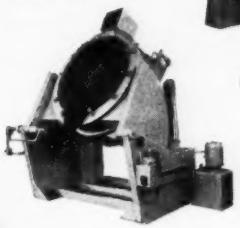

Electric Tray Loaded Oven


Iron Pot Melting Furnace

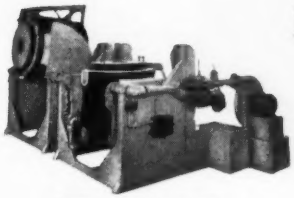

Double Chamber Aluminum Melting and Holding Furnace


Double Chamber Barrel Furnace


Stationary Crucible Melting Furnace


Hydraulic Tilt Iron Pot Furnace

Electric Crucible Holding Furnace


Mechanically Tilted Crucible Melting Furnace

Gas-Fired Crucible Melting and Holding Furnace

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HEVI-DUTY ELECTRIC COMPANY, MILWAUKEE 1, WISCONSIN

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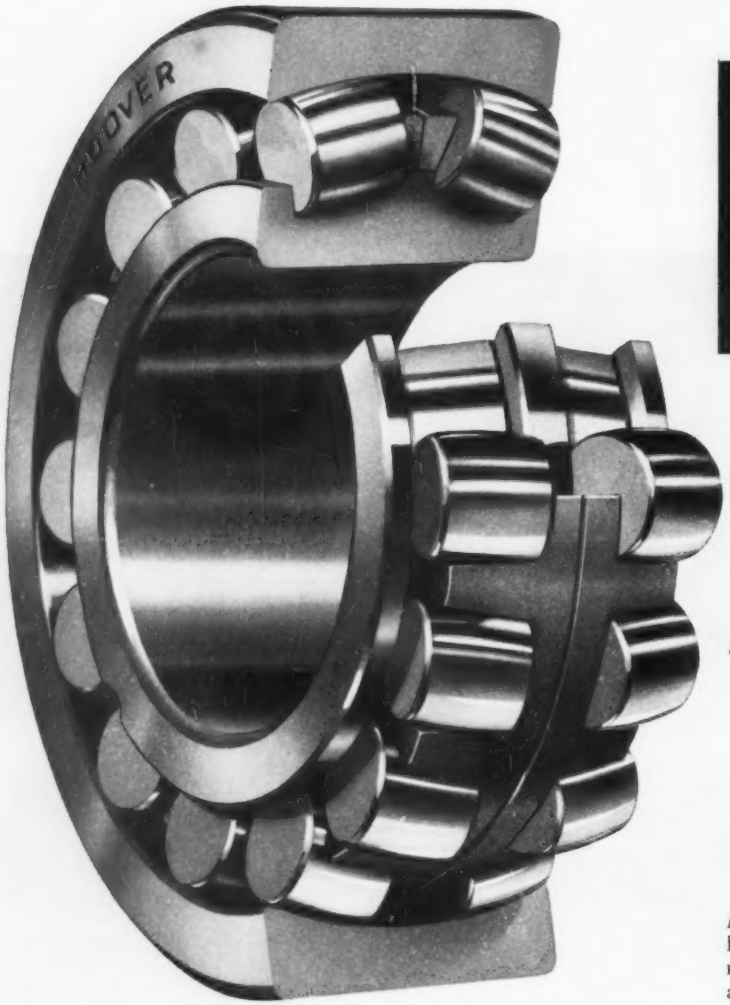
HOOVER *super finish* RACEWAYS AND ROLLERS



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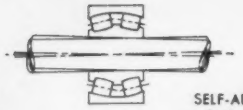
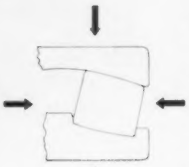
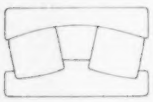
Complete Range of Series and Sizes



SELF-ALIGNING—Hoover spherical roller bearings automatically compensate for shaft misalignment in any direction, either initially or dynamically under load.



RADIAL OR THRUST LOADS—Double row of large-size rollers provides capacity for heavy radial and shock loads. High contact angle provides substantial thrust loads in either direction.



ACCURATE ROLLER GUIDANCE is assured by heavy center flange guide, asymmetrical roller design and heavy machined bronze, land-riding retainers.

Hoover Quality spherical roller bearings have two rows of large-size convex rollers to provide exceptional radial and shock load capacity. In addition to the important features illustrated above, Hoover spherical roller bearings utilize a land-riding, machined solid bronze retainer capable of withstanding high stress. Hoover roller guidance features, plus precision matching of *Super Finish* rollers and raceways, assure uniform load distribution, low operating temperatures and enduring performance. Available in a complete range of series and sizes—with cylindrical or tapered bore.

HOOVER BALL AND BEARING COMPANY S-10
5400 South State Road, Ann Arbor, Michigan

Please send information about the roller bearings checked:

☐ Spherical roller bearings ... Bulletin No. 113

☐ Cylindrical roller bearings ... Bulletin No. 114

☐ Have your representative call.

Name _____

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In Roller Bearings

ASSURE EXTRA LONG LIFE . . . SUPERIOR PERFORMANCE

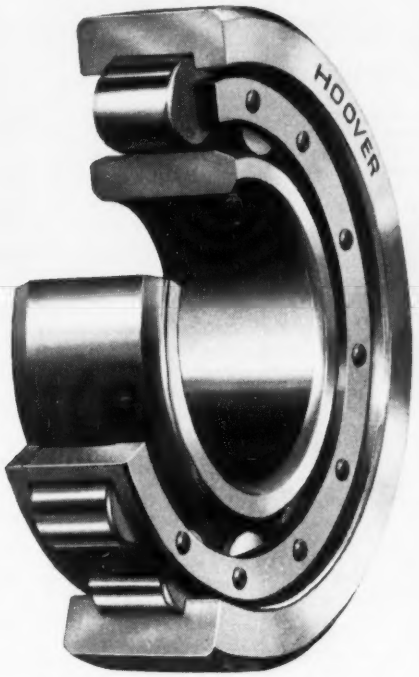
Depend on Hoover to set new high standards for roller bearing quality . . . *Hoover Quality!*

In roller bearings, *Hoover Quality* means that raceways and rollers are *Super Finished* to gleaming, mirror-like smoothness. It is this *Super Finish* that results in longer bearing life and superior performance.

Hoover enters the roller bearing field with complete lines of the most widely used of spherical and cylindrical types. Hoover roller bearings are accurately made of the finest of materials. They utilize the most successful of operating and design features. They assure you the best in roller bearing performance for a wide range of applications.

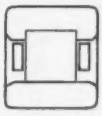
CYLINDRICAL Roller Bearings

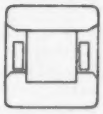
Complete Range of Series and Sizes

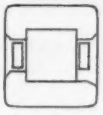


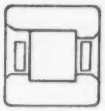
Hoover Quality cylindrical roller bearings are designed with crowned rollers that provide uniform load distribution for maximum radial load capacity and minimum friction. Because they are cool running, high speed operation under heavy radial loads is possible.

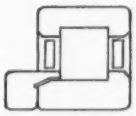
Rollers and raceways are *Super Finished* to mirror-like smoothness for quiet operation and long life. Retainers are machined solid bronze assuring strength and accurate roller guidance. Available in a complete range of series and sizes in the types pictured at right.


Type NU—Straight inner race


Type N—Straight outer race


Type NJ—Single flanged inner race


Type NF—Single flanged outer race


Type NH—Single flanged inner race with stabilizing ring

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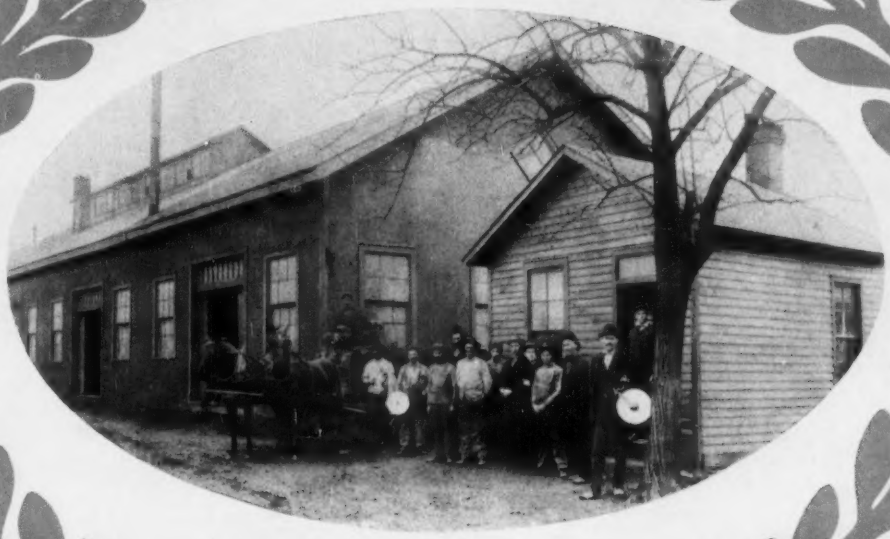


The first Ingersoll plant, at Sandoval, Illinois
as it appeared in 1899

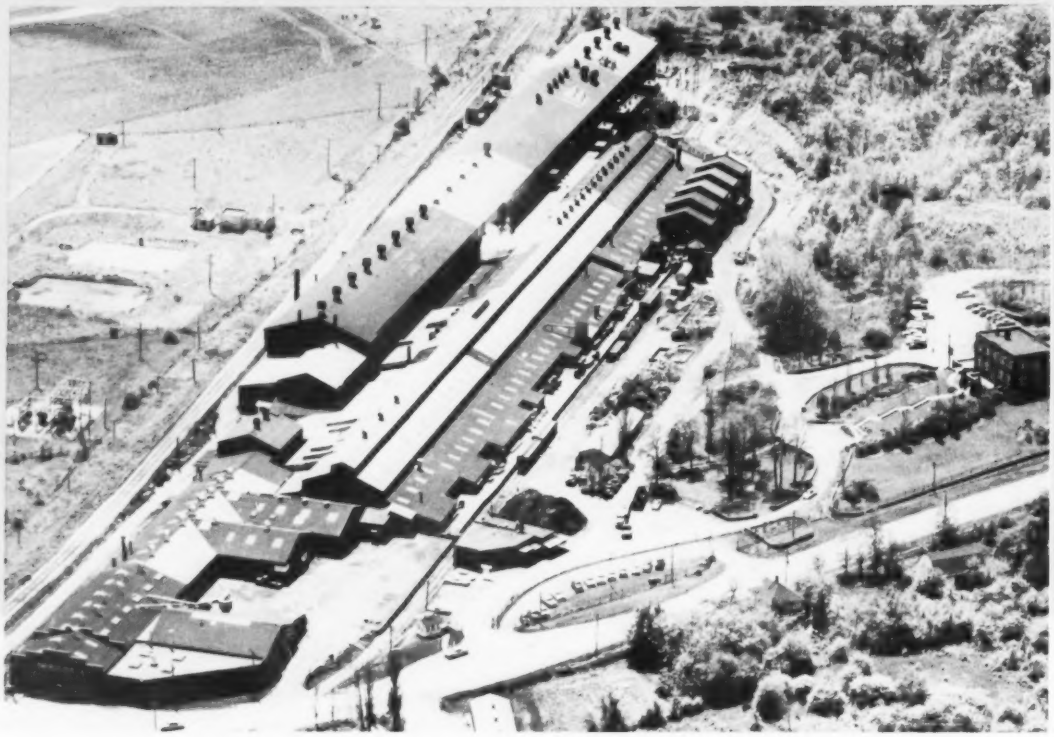
1884 *1959*

On Their 75th Anniversary

BORG-WARNER ENGINEERING B-W PRODUCTION **CORPORATION**

Ingersoll *Steel Division*

1884 75 1959 YEARS



Special Purpose Steels for Industry

In 1884, with a handful of employees and a small factory, Stephen A. Ingersoll founded the company that today includes four separate Borg-Warner Divisions, and the management and operation of a B-W subsidiary.

During these 75 years the Ingersoll employee force has grown to several thousand; manufacturing facilities have expanded to seven modern plants with approximately 2,000,000 square feet of space; and extensive product diversification now serves many industries.

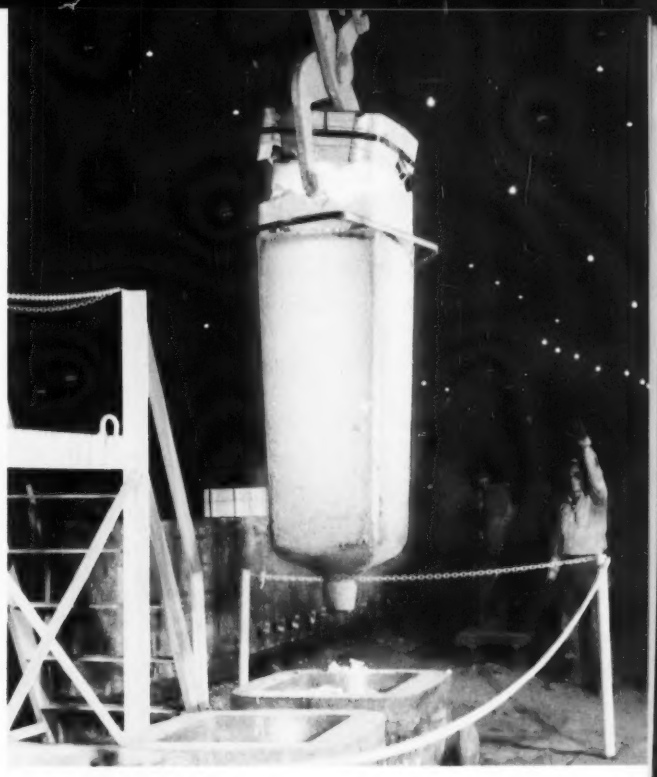
The New Castle, Indiana plant of INGERSOLL STEEL DIVISION was acquired in 1917 to supply the original company's expanding steel needs. Today INGERSOLL STEEL produces a wide variety of special purpose steels for industry. These include stainless and stainless-clad steels, heat resisting steels, high carbon and alloy steels, forging quality electric furnace alloy steel ingots, automotive clutch plate steels, cross-rolled tillage steel, soft center plow steels, knife and saw steels, high speed hack saw steels, and other special analysis steels.

In addition, INGERSOLL STEEL fabricates flat and formed agricultural discs, automotive and tractor clutch discs, steel hand shovels, spades and scoops, lightweight aluminum alloy scoops, and stainless steel scoops.

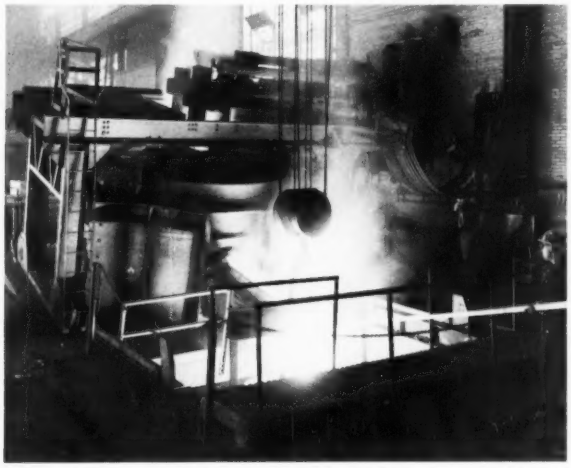
Back of all these products is the continuing Borg-Warner aim: "Design it better—make it better"—a tradition that benefits almost every American every day.

DESIGN IT BETTER INGERSOLL STEEL B-W BORG-WARNER® *MAKE IT BETTER*

Ingersoll Soft-Center steel is widely used by the farm implement industry in plow shares, moldboards, landsides, jointer blades and cultivator shovels.



Ingersoll Steel produces forging quality electric furnace alloy steel ingots up to 23,000 pounds in size.



One of four electric furnaces for the melting of many kinds of special purpose steels.

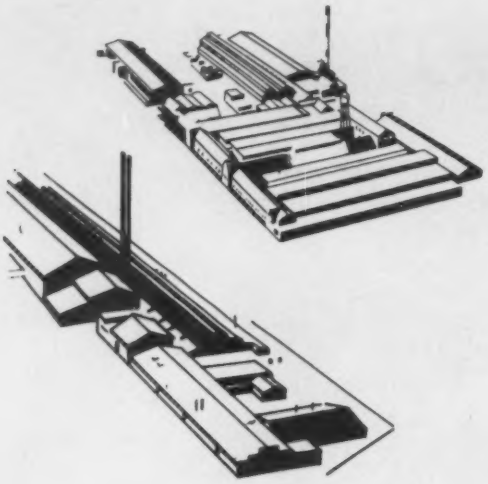
To provide fast service on hurry-up orders, Ingersoll Steel maintains substantial stocks of stainless, high speed and alloy sheets, plates and ingots.

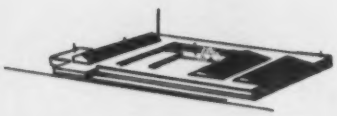
In the production of shovels, spades and scoops, Ingersoll Steel is the only manufacturer that melts, rolls and completely fabricates its own shovel steel. Ingersoll also produces lightweight aluminum alloy shovels and scoops.

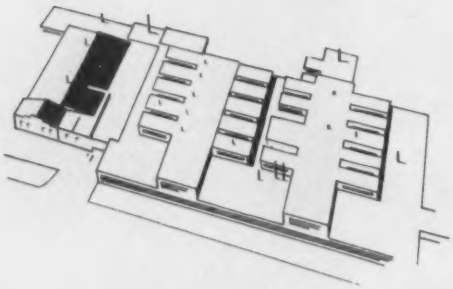
The Challenge . . . *and the Promise*

Recognizing that the achievements of the past are but a guide to the future, the Ingersoll Divisions of Borg-Warner reaffirm their continued adherence to the principles established by their founder—integrity of purpose, quality of product, and dedicated service. This is the Ingersoll challenge . . . and the Ingersoll promise.

THESE ARE THE INGERSOLL DIVISIONS OF BORG-WARNER







INGERSOLL PRODUCTS, Chicago, Illinois. Plow and harrow discs and coulter blades, pressed steel implement wheels, tractor seats and instrument panels, and other farm implement parts; tapered discs for truck wheels; formed and deep drawn steel stampings; raw and porcelain enameled washing machine tubs and components; porcelain enameled steel sinks and bathtubs; solid fuel furnaces; industrial cranes and hoists.

INGERSOLL STEEL, New Castle, Indiana. Open hearth and electric furnace high carbon and alloy steels; soft center plow steels; stainless and heat-resisting steels; stainless-clad steel sheets; forging quality electric furnace alloy steel ingots; high speed hack saw steels; agricultural flat and formed discs; automotive and tractor clutch discs; hand shovels, spades and scoops; lightweight aluminum scoops; stainless steel shovels and scoops.

INGERSOLL KALAMAZOO, Kalamazoo, Michigan. Materials handling equipment (Load Lugger System); special vehicles for the military; rocket motor cases and guided missile boosters; design agents for LVT amphibian landing vehicles.

REFLECTAL CORPORATION, Chicago, Illinois. (Ingersoll managed). Alfol aluminum foil reflective insulation for buildings; asbestos insulation; jacketing; KoolShade sun screen; Betocel cellular insulating concrete.

INGERSOLL-HUMPHRYES, Mansfield, Ohio. Enameled cast iron and steel bathtubs, sinks and lavatories; vitreous china water closets and lavatories; plumbing fixture fittings.

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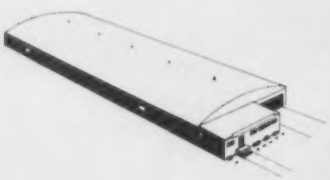

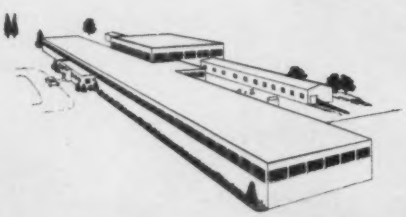

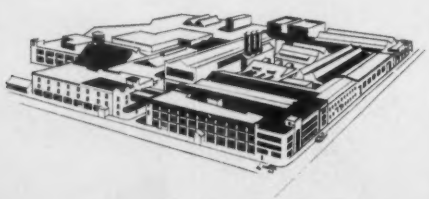

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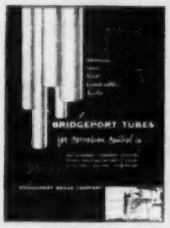
4. Condenser & Heat Exchanger Tube Handbook — 162 pages. Covers installation or replacement of Condenser or Heat Exchanger Tubes, helps you select the best alloys for efficient, economical, low maintenance operation.

5. Bridgeport Special Metals Development Plan — 12 pages. See how Bridgeport is transforming Zirconium, Titanium, Columbium, or Tantalum from costly rarities to readily available materials in tube, rod, sheet, extruded or forged shapes.

6. Bridgeport Alloys —Copper, Brass, Bronze — 8 pages. Complete chemical, physical, mechanical properties, uses and specifications. Easy-to-read charts allow comparison of metals without confusion.



7. Bridgeport Tubes—Aluminum, Brass, Copper, Special Metals, Duplex — 4 pages. Gives corrosion-control data on both single wall and duplex tubes, properties and applications.

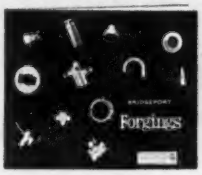
8. Grain Size—The 4th Dimension of Brass—6 pages. Tells how selecting correct grain size of a metal may lower your production and finishing costs.

9. Bridgeport Plumbing, Heating and Air-Conditioning Products— 4 pages. Complete type, size, weight and strength data on brass and copper pipe and tube.

10. Index of Bridgeport Products, Alloys, Forms—4 pages. Lists over 250 metal alloys, forms and shapes readily available from Bridgeport.

11. Bridgeport Duplex Tubes—24 pages. Describes advantages of dual metal tubes and tube sheets in solving difficult corrosion problems involving two corrosive media in heat transfer equipment. Includes design, installation data, table of typical applications.

12. Bridgeport Forgings—12 pages. Explains die forging and unique cored forging process in detail. Illustrates specific advantages and engineering possibilities of each.



13. Bronze Welding —Clearly describes Bridgeport's wide selection of rods for gas and arc welding. Gives characteristics, recommended methods of use for each alloy.

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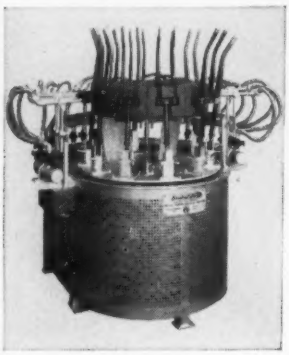
Columbia produces 250 bicycle forks per hour with automatic GAS brazing

Gas brazing is not new to Westfield, where Columbia bicycle frames have been brazed with Gas-fired Selas processing equipment for many years. During this time, pre-placing of brass filler material and automatic heating have limited dependence on operator skill, reduced material waste, and eliminated costly cleanup operations. With the installation of the new Gas brazing machine in their production operation, these advantages have been extended to include fork manufacture, also.

For information on how Gas equipment can help you in your production operations, call your Gas Company's industrial specialist. He'll be glad to discuss the economies and outstanding results you'll get with Gas and modern Gas equipment. *American Gas Association.*



Two fork styles in all standard bicycle sizes are joined from eight steel components on this new automatic Selas machine by Westfield Manufacturing Co., Westfield, Mass. Controlled combustion and flame geometry bring the parts to brazing temperature of 1750°F in only 86 seconds, using economical Gas equipment.

Here's how Olin Aluminum can help you get more extrusions for your dollar. We make aluminum — so we're thoroughly acquainted with the properties of all extrusion alloys. We're also experts in extrusion design and the related art of die-making. Combining this overall knowledge, we can help you achieve extrusions that use a minimum of metal with a maximum of efficiency.

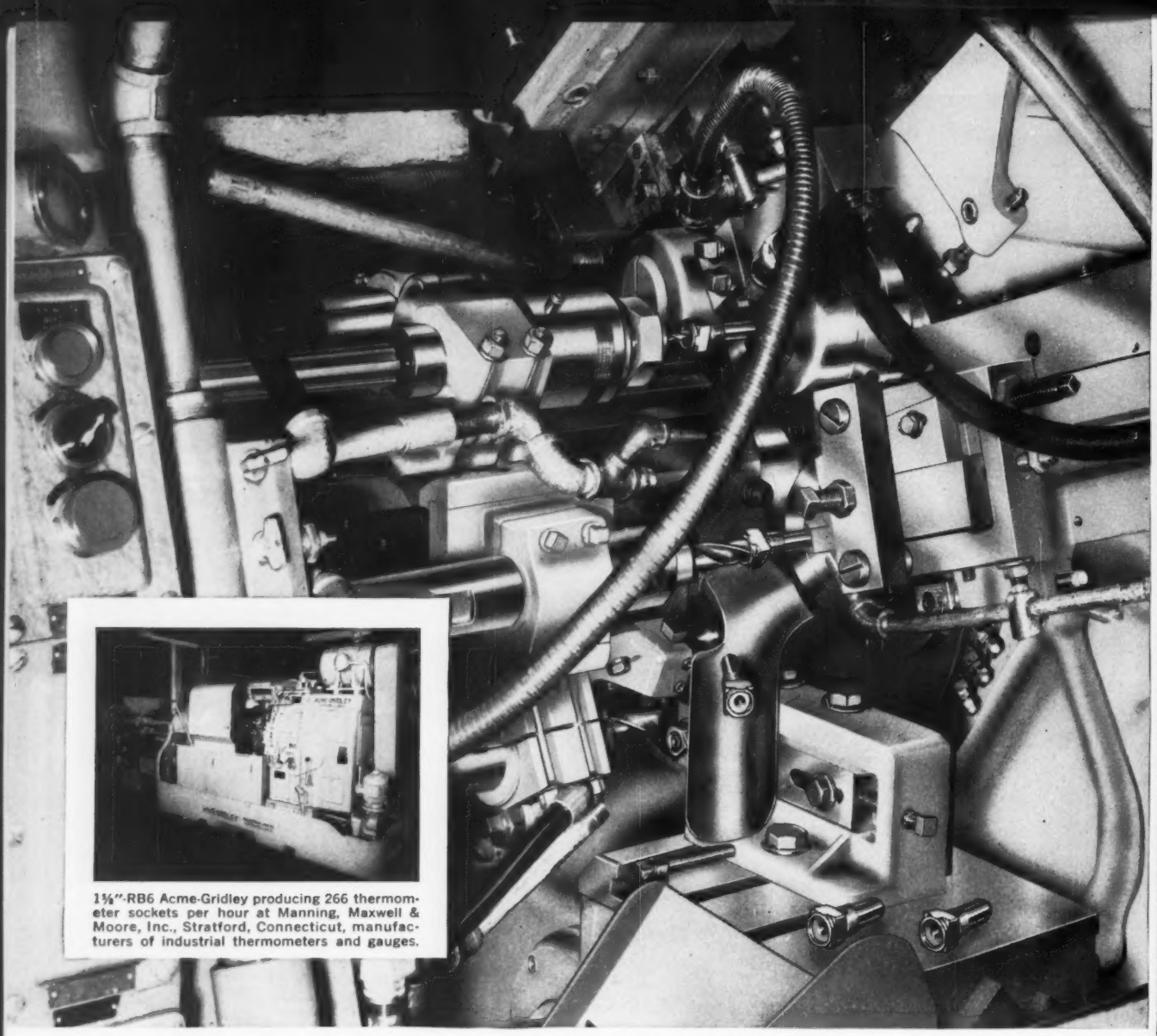
Come to us with an idea of what you want to accomplish and we'll show you how to do it best — whether it involves standard extrusions or elaborate, special-purpose, multi-port dies such as that used to produce the trademark extrusion illustrated.

And you can count on quality, too! For Olin Aluminum, as a primary producer of aluminum, tests its metal at every stage of the production process . . . using such advanced methods as quantometric analysis.

Moreover, your source of supply is assured by this fact: every Olin Aluminum customer is the terminal point of a massive, unbroken chain of supply that extends from the bauxite mine to the extrusion press.

OLIN ALUMINUM®

OLIN MATHIESON • METALS DIVISION • 400 PARK AVE. • NEW YORK 22, N. Y.



1¼"-RB6 Acme-Gridley producing 266 thermometer sockets per hour at Manning, Maxwell & Moore, Inc., Stratford, Connecticut, manufacturers of industrial thermometers and gauges.

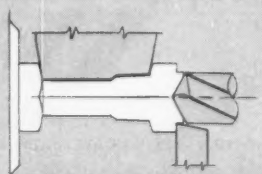
Close-up of tooling zone showing 4th and 5th position operations.

Spindle-for-Spindle

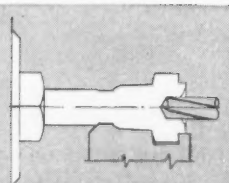
PRODUCTION INCREASED OVER 200%

for Manning, Maxwell & Moore, Inc.

12 Operations in 22 Seconds



6. Rough Form Rear Diameters —Spot Drill—Turn Front Diameter



1. Finish Form Thread and Front Diameter—Drill ⅜" Diameter

NATIONAL ACME'S "ZONE OF RESPONSIBILITY"
INCLUDES ALL PHASES OF COST REDUCTION

Check YOURS . . . Then Check National Acme

Direct Costs: these include direct dollar savings as realized by Manning, Maxwell & Moore, Inc. . . . an "every day" job for Acme-Gridleys.

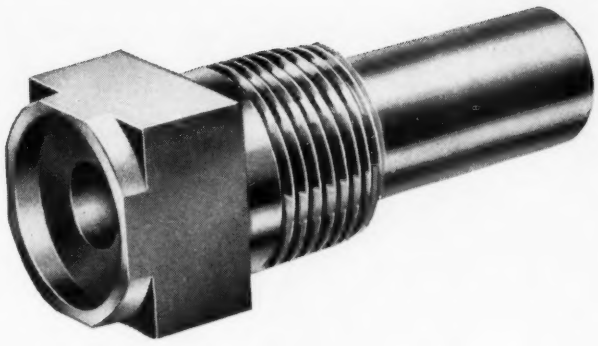
Indirect Costs: effecting important savings in maintenance, downtime, scrap reduction, tool costs, etc.

Product Redesign: teaming with your design group to take full advantage of Acme-Gridleys' cost reducing capabilities.

Direct Material Costs: our engineers provide important savings in this area by constantly matching machines and tools to modern metallurgical problems.

Make-or-Buy Reviews: in many cases our Contract Division can assume your production headaches and relieve you of immediate capital investment.

Spot Modernization: pioneering in modern tooling methods, and the flexibility of Acme-Gridleys can provide many "on-the-spot" savings.

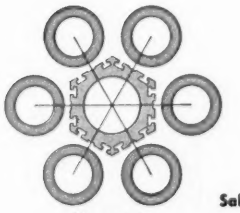


"*Cost-per-piece is substantially reduced* . . . and our increased production has enabled us to keep ahead of competition," says this manufacturer of precision industrial thermometers, gauges and valves.

"Former automatics could not keep pace with production requirements . . . many parts had to be 'farmed out', thus increasing our costs. In addition, the only downtime has been the short periods necessary for tool grinding. What's more . . . a secondary operation for deep-hole drilling was completely eliminated!"

Further benefits were realized with Acme-Gridleys' quick-change, quick-setting toolholders and wide-open tooling zones which enabled Manning, Maxwell & Moore to produce two other parts on the same machine...with only minor changes in the set-up. Add to this the extreme accuracy and flexibility of direct camming and independently operated toolslides, and you will realize why this manufacturer found his Acme-Gridleys a profitable investment.

It will pay *you* to investigate the complete story on the industry's more modern approach to cost reduction. Call, write or wire.

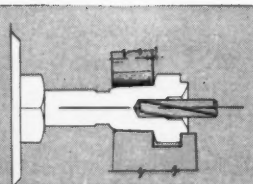


Pioneer in Circumferential Automation

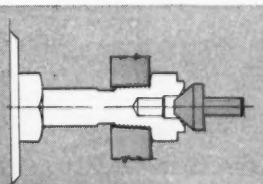
National Acme

THE NATIONAL ACME COMPANY
189 E. 131st STREET
CLEVELAND 8, OHIO

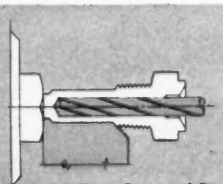
Sales Offices: Newark 2, N.J.; Chicago 6, Ill.; Detroit 27, Mich.



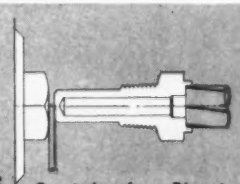
2. Shave Thread and Front Diameter—Drill 5/16" diameter partway



3. Roll Thread—Support



4. Finish Form Rear and Breakdown for Cutoff—Drill 5/16" diameter remainder



5. Counterbore Large Diameter—Cutoff

CF&I - CLAYMONT

produces heads to fit your needs

The CF&I Image—a giant steelman—is a reflection of CF&I's wide range of steel products used by many industries.

The Image reflects CF&I's versatility in producing **CF&I-Claymont Heads:**

. . . in all sizes

- spun heads, precision-formed, from 9 inches up to 19 feet in diameter
- pressed heads (hot or cold formed) up to 10 feet in diameter
- in gages up to 6″

. . . in all shapes

- standard or ASME flanged and dished, conical, elliptical and hemispherical shapes, and special shapes, including: flanged and reverse dished, dished only, flared and dished, flanged and shallow dished, flanged only, as well as large segmented and welded shapes

. . . in all metals

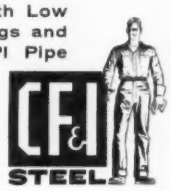
- including: carbon, alloy, stainless and stainless-clad steels, aluminum alloys, brass, bronze, copper, Hastelloy, Inconel, Monel, and other ferrous and non-ferrous metals

. . . from large head stocks maintained at CF&I warehouses located coast-to-coast

. . . or made-to-order promptly at the Claymont plant

For complete information and order service, contact the CF&I warehouse or district sales office nearest you.

CF&I-CLAYMONT PRODUCTS: Carbon Steel Plates • Alloy Steel Plates CF&I Lectro-Clad Nickel Plated Steel Plates • Clay-Loy High Strength Low Alloy Steel Plates • Flanged and Dished Heads • Manhole Fittings and Covers • Fabricated Steel Plate Products • Large Diameter API Pipe



Claymont Steel Products

THE COLORADO FUEL AND IRON CORPORATION

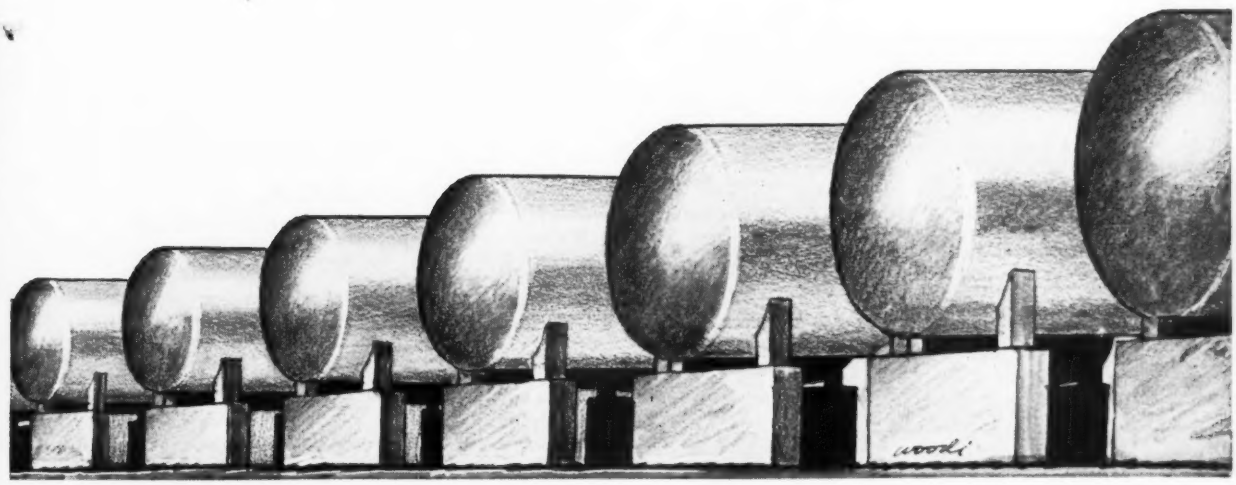
In the West: **THE COLORADO FUEL AND IRON CORPORATION** — Albuquerque • Amarillo • Billings • Boise • Butte • Denver • El Paso Ft. Worth • Houston • Kansas City • Lincoln • Los Angeles • Oakland • Odessa • Oklahoma City • Phoenix • Portland (Ore.) • Pueblo Salt Lake City • San Francisco • San Leandro • Seattle • Spokane • Tulsa • Wichita

In the East: **WICKWIRE SPENCER STEEL DIVISION** — Atlanta • Boston • Buffalo • Chicago • Detroit • New Orleans • New York • Philadelphia

CF&I OFFICE IN CANADA: Montreal

CANADIAN REPRESENTATIVES AT: Calgary • Edmonton • Vancouver • Winnipeg

6624



YOU CAN FIND BOTH THE BIGGEST AND THE BEST AT YOUR COMMERCIAL HEAT TREATER

1

2

3

1 *A new gas fired Homocarb said to be the world's largest.*

2 *A Vacuum Heat Treating Furnace for special materials.*

3 *Large capacity vertical furnace for heat treating large parts.*

The three furnaces shown on this page are units of the facilities of commercial heat treating plants in three different sections of the country.

Today, with the ever growing demand for *better* heat treating, economical volume equipment of this sort is becoming essential and the commercial heat treater has been alert to industry's requirements.

Quality work and versatility are the keynotes of this industry's objectives when treating the thousands of vital, intricate, and costly components of important products.

Whatever your heat treating problem, and whether it involves pounds or tons, always consult your commercial plant first.

CONSULT YOUR
COMMERCIAL HEAT TREATER

THERE'S A HEAT TREATING SPECIALIST NEAR YOUR PLANT

American Metal Treatment Co.
Elizabeth, New Jersey

Benedict-Miller, Inc.
Lyndhurst, New Jersey

Bennett Heat Treating Co., Inc.
Newark 3, New Jersey

Cook Heat Treating Co. of Texas
Houston 11, Texas

The Dayton Forging & Heat Treating Co.
Dayton 3, Ohio

Duminy Heat Treating Corp.
Dallas, Texas

Fred Heinzelman & Sons, Inc.
New York 12, New York

Alfred Heller Heat Treating Co.
New York 38, New York

Ipsenlab of Rockford, Inc.
Rockford, Illinois

Ipsenlab of Canada Ltd.
Toronto, Ontario

L-R Heat Treating Co.
Newark, New Jersey

Metallurgical, Inc.
Minneapolis 14, Minnesota

Metallurgical, Inc.
Kansas City 8, Missouri

Owego Heat Treat, Inc.
Apalachin, New York

Paulo Products Company
St. Louis 10, Missouri

Pittsburgh Commercial Heat Treating Co.
Pittsburgh 1, Pennsylvania

The Queen City Steel Treating Co.
Cincinnati 25, Ohio

J. W. Rex Company
Lansdale, Pennsylvania

Stanley P. Rockwell Company
Hartford 12, Connecticut

Scott & Son, Inc.
Rock Island, Illinois

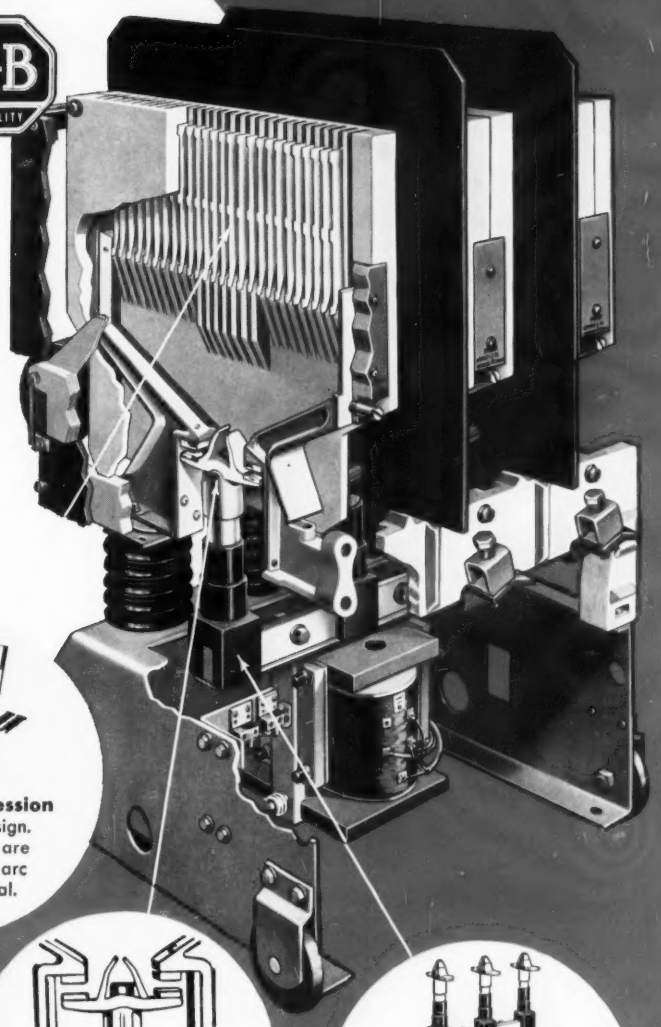
Syracuse Heat Treating Corp.
Syracuse, New York

Temperature Processing Co.
North Arlington, New Jersey

United Heat Treating Co.
Fort Worth 7, Texas

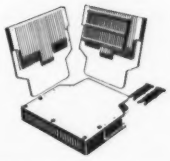
Here's the inside story of industry's

MOST RUGGED HIGH VOLTAGE SWITCH



THIS SOLENOID AIR BREAK CONTACTOR IS THE HEART OF THE A-B STARTER LINE

A tremendous operating life has been built into these new A-B high voltage, air break starters by using the same simple solenoid design—with only ONE moving part—that has proved good for millions of trouble free operations in Allen-Bradley low voltage starters. A-B high voltage starters are made for all types of service and for all types of motors up to 1500 hp, 2300 v; 2500 hp, 4600 v. Send for Publication 6080, today.

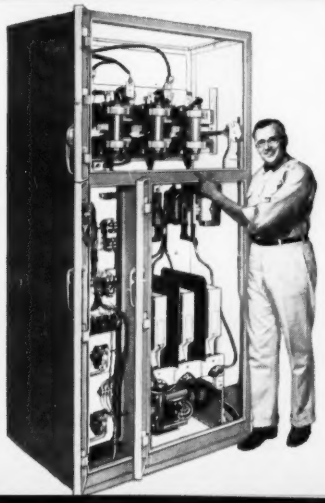


Faster Arc Suppression
New blowout design. Novel arc chutes are molded from an arc resistant material.

Double Break Contacts
Silver alloy contacts never need maintenance. Vertical motion assures uniform contact pressures.

Only One Moving Part
Simple solenoid design eliminates trouble-causing pins, pivots, and flexible jumpers.

B-39-RM



A-B High Voltage Starter with Air Break Contactor

Bulletin 1159 high voltage air break, across-the-line induction motor starter in NEMA Type 1 enclosure. All Allen-Bradley high voltage starters are equipped with current limiting fuses with interrupting capacities of 150,000 kva at 2300 v; 250,000 kva at 4600 v.

ALLEN-BRADLEY

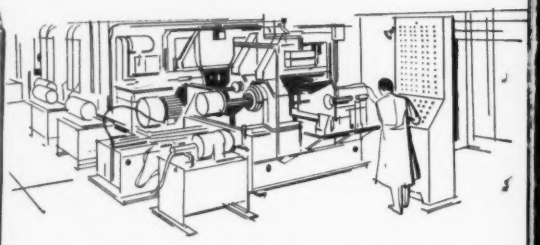
Member of NEMA

Quality Motor Control

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

AUTOMATION BEGINS HERE

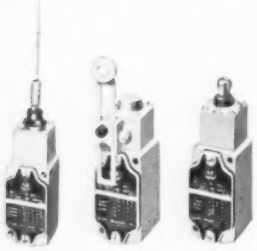
. . . Insist on Allen-Bradley accessories for continuous automatic production



In this broad line of Allen-Bradley accessories, each and every unit carries the traditional A-B trademark of *quality* that stands for trouble free operation. Rugged construction, and maintenance free, silver alloy contacts provide the reliability that is essential to the continuous operation of *your* automatic production machines.

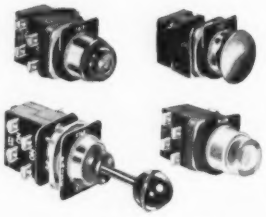
Profit from the experience of the leading machine tool builders . . . insist on Allen-Bradley *quality* motor control *all the way!*

▲ Special push button panels can be assembled to your specifications.

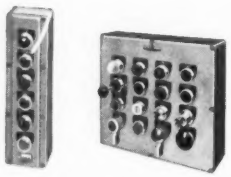


OILTIGHT LIMIT SWITCHES
Bulletin 802T with sealed heads and bodies. Various operators.

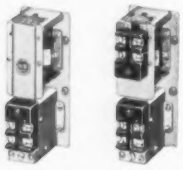
PRECISION LIMIT SWITCH
Bulletin 802 oiltight. Responds to very small operator travel.



OILTIGHT CONTROL UNITS
Bulletin 800T. Choice of push buttons, lights, and switches.

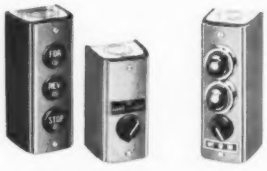


OILTIGHT CONTROL STATIONS
Bulletin 800T for up to 16 units in die cast aluminum enclosure.

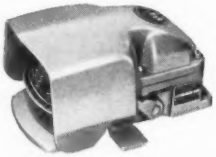


PNEUMATIC TIMERS
Bulletin 849. Reliable and accurate. For on-delay or off-delay.

OILTIGHT PRESSURE CONTROL
Bulletin 836. For hydraulic systems with pressures to 5000 psi.



STANDARD DUTY PUSH BUTTONS
Bulletin 800. Up to three units, also pilot lights and switches.



FOOT SWITCH
Bulletin 805. In rugged die cast housing for toughest service.

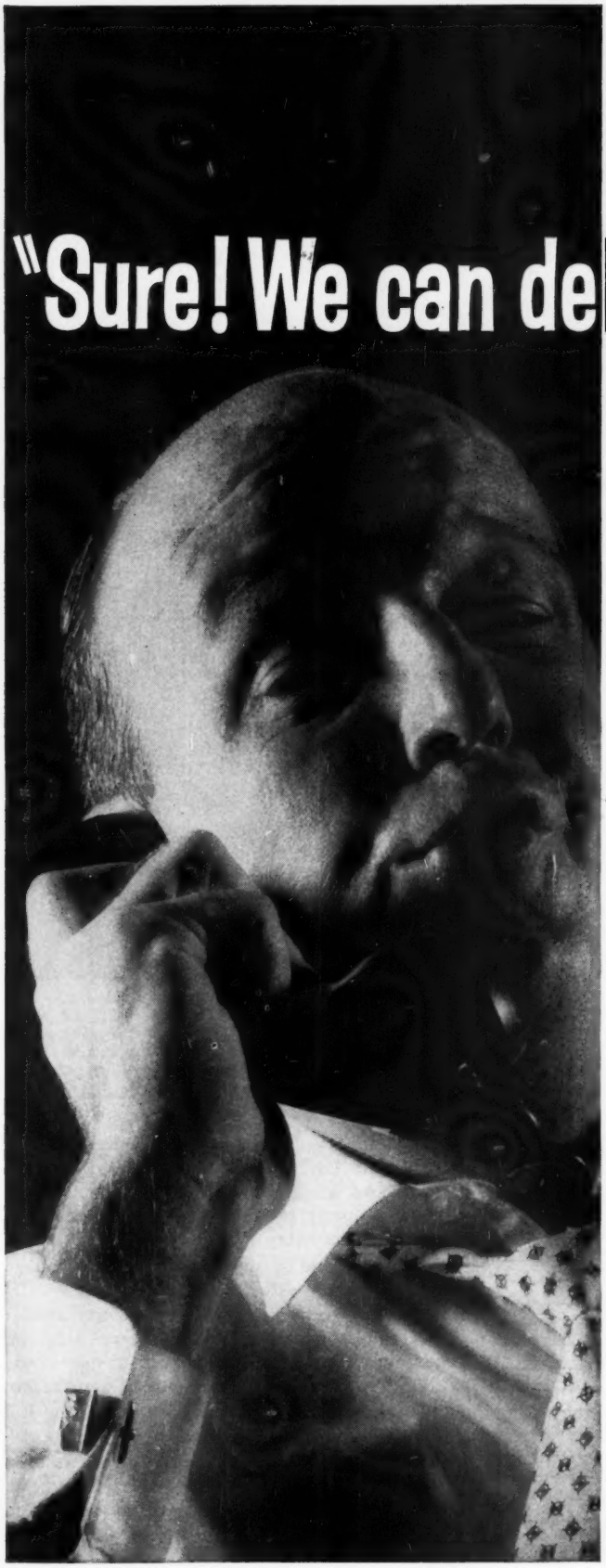
8-59-RM

ALLEN-BRADLEY

Member of NEMA

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

QUALITY MOTOR CONTROL



Whose neck is he sticking out, anyway, when your production man says,

"Sure! We can deliver on time!"

Yours, isn't it?

Doesn't he mean, "We can deliver on time, IF purchasing can get us the materials we need".

That's why you rely on Lincoln for welders and electrodes.

Lincoln has factory branch offices in every important city, staffed by trained engineers who will help you with production and cost reduction problems.

37 Lincoln warehouses throughout the United States assure prompt delivery of your order, no matter where your plant is located.

1200 authorized Lincoln dealers throughout the country supply rapid service to small users . . .

While 225 factory-trained Field Service Shops provide preventative maintenance and repairs.

Lincoln products are famous for the very highest quality at lowest possible cost.

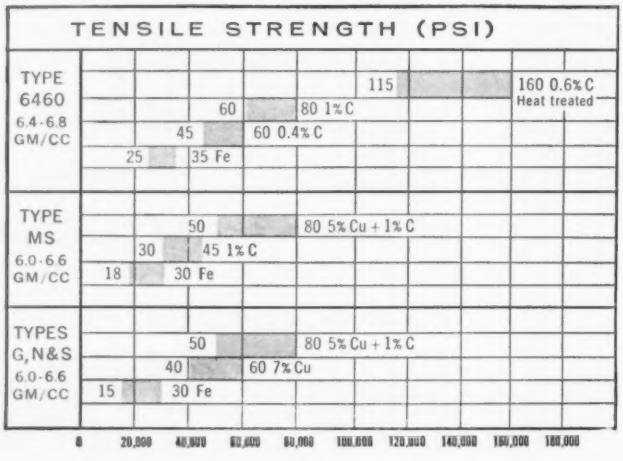
LINCOLN ...USA

THE LINCOLN ELECTRIC COMPANY

Department 1658 • Cleveland 17, Ohio

World's leading manufacturer of arc welding equipment, ac motors and battery chargers.

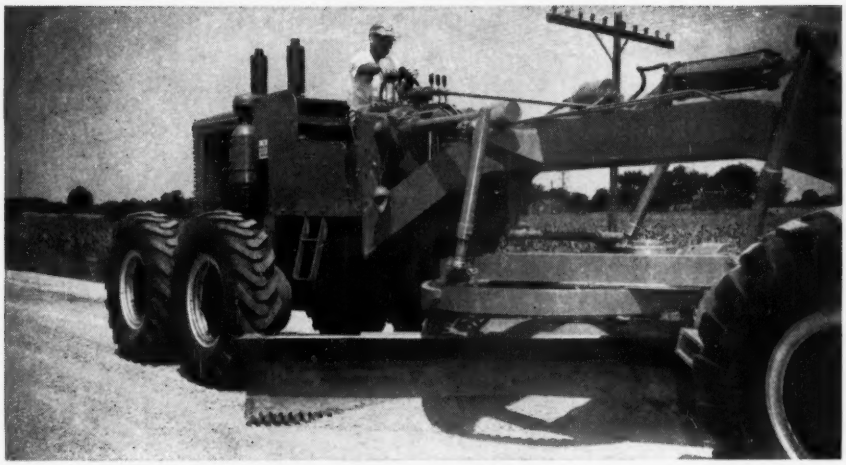
5 REPUBLIC METAL POWDERS GIVE YOU BROAD SPECTRUM COVERAGE



Just as a spectrum represents a series of wave lengths from low to high, Republic's wide range of iron and alloy powders covers all known physical property requirements of metal powder part fabricators today.

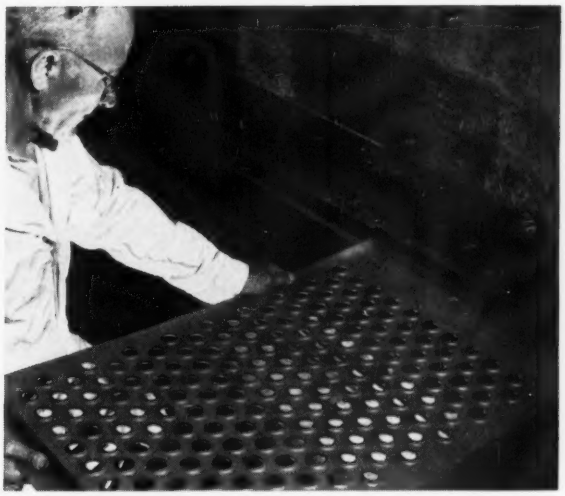
This broad band of coverage, denoted by density and type, is graphically illustrated by the following Republic powders: Controlled Dimensional Factor Types "G" for growth, "N" for normal or zero dimension change, "S" for shrinkage—copper compatible; Type MS—carbon compatible; and carbon compatible, Type HS6460 alloy.

Booklet, ADV. 1014 contains complete technical information on Types G, N, S, and Type MS. Chemical composition, physical properties, and test evaluations on Type HS6460 are contained in Booklet ADV. 1028. Write for your free copies.



REPUBLIC HOT ROLLED SPECIAL BAR SECTIONS LEVEL OFF COSTS for grader blade manufacturer. Shunk Manufacturing Company, Bucyrus, Ohio, has maintained top-quality and its competitive position for over 30 years by using Republic High Carbon Hot Rolled Special Bar Sections for grader blades. The special bar sections are preformed to the predominating cross section of the blade, thus keeping costs down by eliminating most machining and forming operations. Republic Special Bar Sections are available hot rolled or cold drawn in carbon, alloy, and stainless steel. Send coupon for full facts.

REPUBLIC NYLOK® FASTENERS PROVIDE SECURE HOLDING POWER where it's needed most in the Twin Power Riding Mowers produced by Roberton Manufacturing Company, Chicago. A special nylon insert assures positive locking, maximum holding power—even under severe vibration. The insert in nylok fasteners is unaffected by age or cold, has high resistance to heat. For more facts on Republic Nylok Fasteners, mail the coupon.



REPUBLIC GALVANNEALED SHEETS SOLVE CORROSION PROBLEM in Kathabar® units manufactured by Surface Combustion Corporation. Units are designed to lower or raise the relative air humidity through evaporation or absorption of moisture. Republic Galvannealed, used for coil tube sheets, takes all forming operations. Corrosion and rust problems are held to an absolute minimum. Mail coupon for literature.

REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products

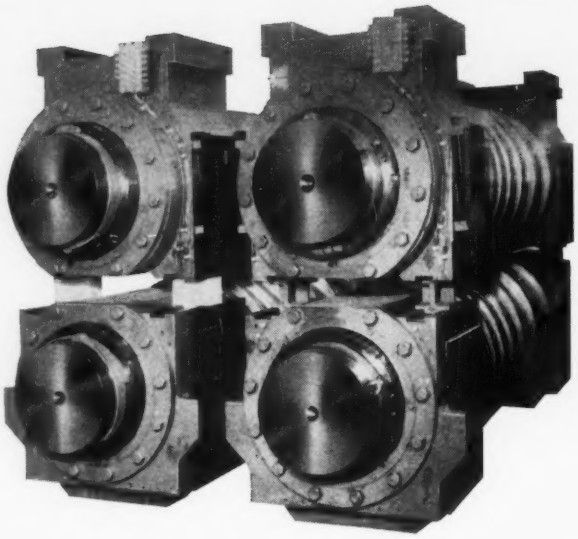
REPUBLIC STEEL CORPORATION
DEPT. ST-8123-B
1441 REPUBLIC BUILDING · CLEVELAND 1, OHIO

Please send the following Metal Powder Booklets:
☐ ADV. 1014 on Types G, N, S, and MS.
☐ ADV. 1028 on Type HS6460

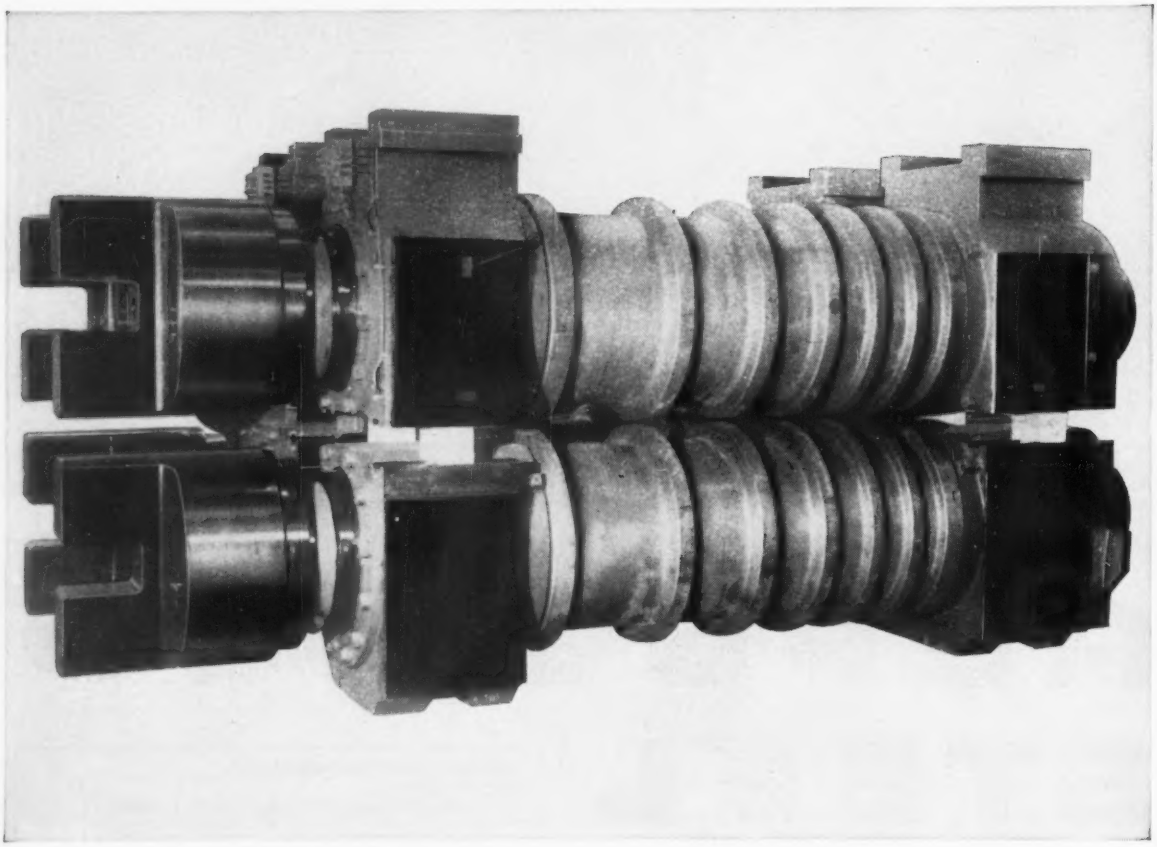
Send more information on:
☐ Special Bar Sections ☐ Nylok Fasteners
☐ Galvannealed Sheets

Name _____ Title _____
Company _____
Address _____
City _____ Zone ____ State _____

Ready to Roll . . .



• another set of thoroughbreds—this time for one of America's largest steel producers . . . ready to carry a top production load. BIRDSBORO "breeding" starts way back in the laboratory, where advanced research results in a specialized family of rolls to meet the toughest mill requirements. BIRDSBORO rolls are favorites in all production races . . . and they can be real profit winners for you. *Sales Department, Engineering Department and Mfg. Plant:* Birdsboro, Pa., *District Office:* Pittsburgh, Pa.

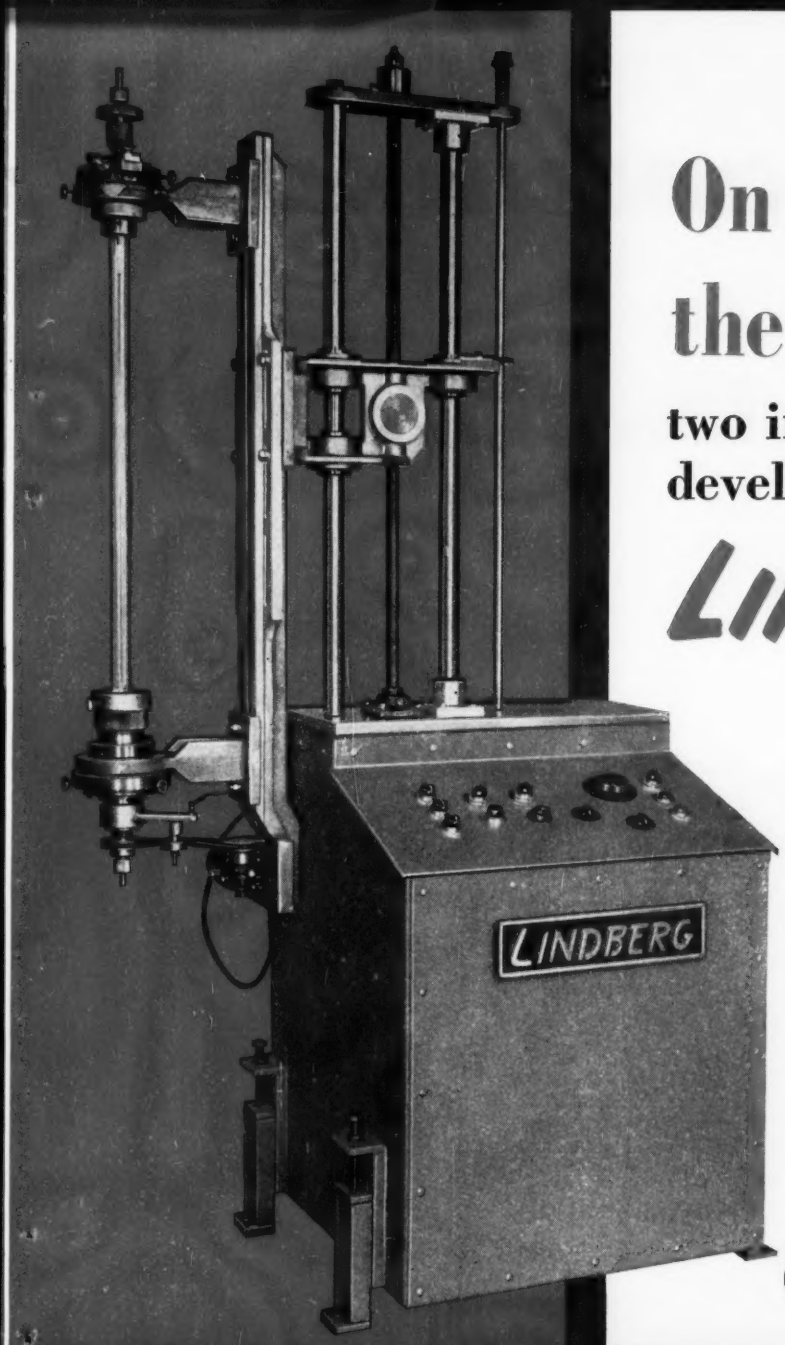


R-29-59

BIRDSBORO

STEEL FOUNDRY AND MACHINE CO.

STEEL MILL MACHINERY • HYDRAULIC PRESSES • CRUSHING MACHINERY • SPECIAL MACHINERY • STEEL CASTINGS • Weldments "CAST-WELD" Design • ROLLS: Steel, Alloy Iron, Alloy Steel



On Exhibit at the Metal Show...

two important new developments by

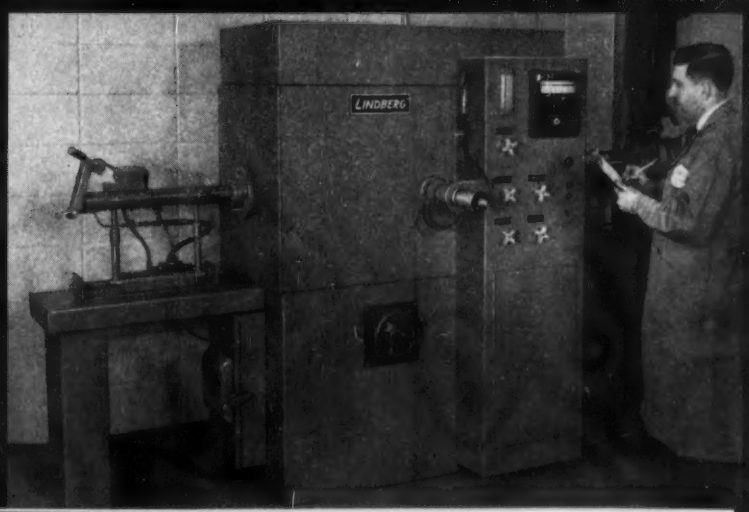
LINDBERG

Visit Lindberg Booth 520 at the Metal Show and see these latest developments by Lindberg engineers.

The New Lindberg Floating Zone Scanner (shown at the left) has been expertly designed to provide more accurate and precise production of high purity semi-conductors and metals. It is an ideal tool for metallurgical research and production of semi-conductor devices.

The new high temperature Graphite Tube Furnace, (shown below) has been developed to meet the demand for higher controlled temperatures for research and small production in the metallurgical and ceramic fields. Its temperature range of 1600° F. to 5000° F. makes it ideal for sintering of powdered metals, firing of ceramic bodies and high temperature chemical reactions.

LINDBERG **heat for industry**



For full information on the new Floating Zone Scanner ask our High Frequency Division for Bulletin No. 1600.

For full information on the new Graphite Tube Furnace ask our Pilot Plant Equipment Division for Bulletin No. T-1084.

LINDBERG ENGINEERING CO.

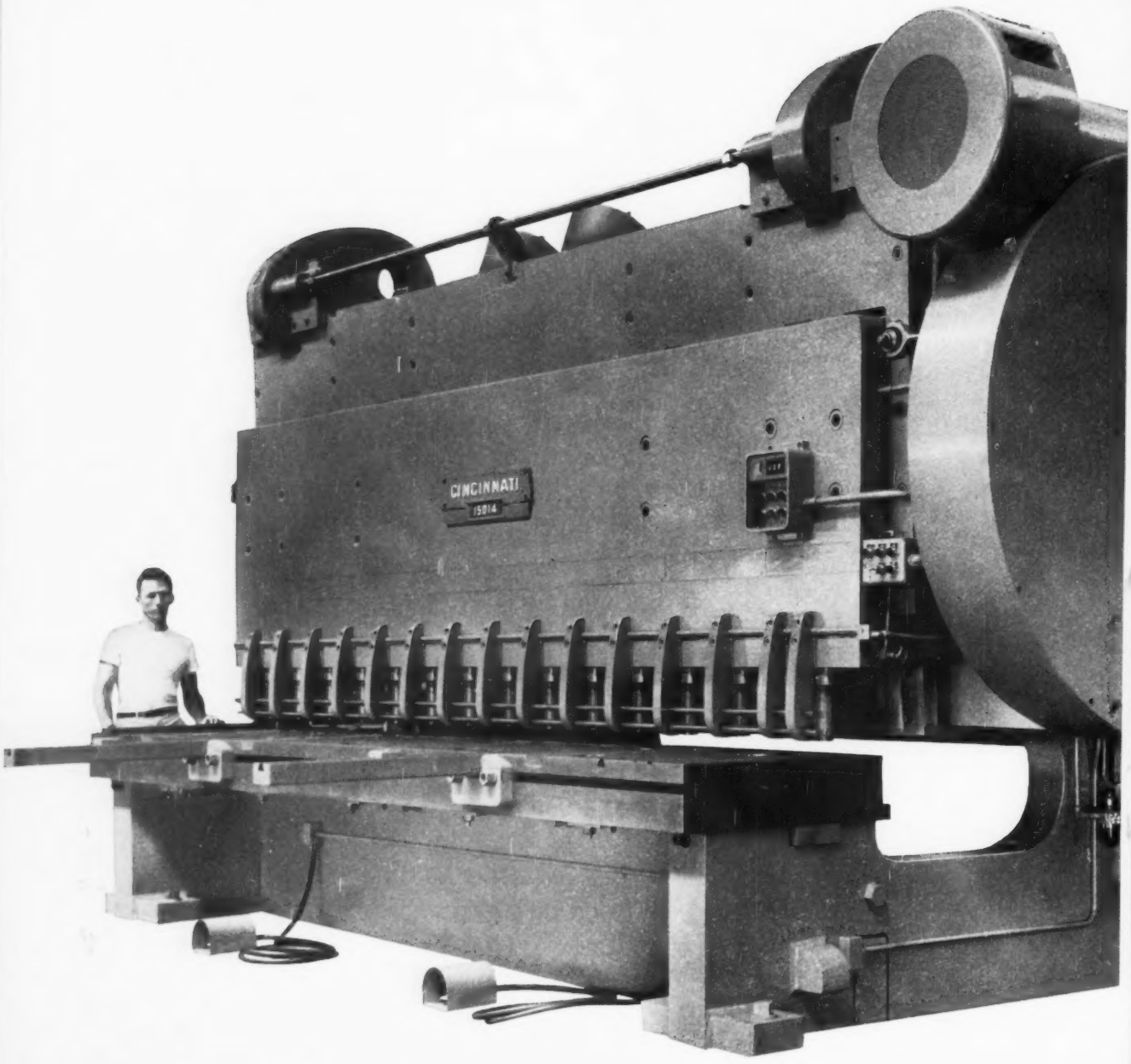
2441 West Hubbard Street, Chicago 12, Ill.

Los Angeles Plant: 11937 South Regentview Avenue, at Downey, California

In Canada: Efco-Lindberg, Ltd., Toronto

This CINCINNATI®...

1¼ in. thick X



shears mild steel plate

14 ft. long

This 15014 Series Cincinnati All-Steel Shear has a 36″ gap and a 48″ back gage range.

Power for heavy cutting with accuracy and operating convenience are combined in this machine.

Modern features such as — Hydraulic Holddowns, Front Operated Power Back Gage, Hinged Back Gage Angle, Automatic Pressure Lubrication, All-Steel Interlocked Construction, Forged Alloy Steel Eccentric Shaft—all contribute to an outstanding performance with low maintenance and high accuracy.

See your Cincinnati Representative for either Heavy or Light Shearing Applications. Write for Catalog S-7R.

Shapers / Shears / Press Brakes

THE CINCINNATI SHAPER CO.

Cincinnati 11, Ohio, U.S.A.

CLAD REX 8-C

How to form and fabricate CLAD-REX® with existing equipment and methods

Clad-Rex vinyl-metal laminates can be formed and fabricated much like any unfinished sheet metal. No costly retooling or special, complex techniques are needed.

Die Forming and Drawing

The vinyl surface of Clad-Rex actually seems to enhance the forming and drawing characteristics of sheet metal. The vinyl in effect becomes a lubricant that permits better flow of metal. Often the tearing and wrinkling of complex draws in unfinished metal is practically eliminated when Clad-Rex is used.

Existing dies can be used by reducing the gauge of base metal to compensate for the thickness of the vinyl. Usually one gauge reduction is enough because the vinyl will compress up to 50% during forming. The inherent "memory" of the vinyl causes it to

Morton Manufacturing Co., Chicago, Ill.

retain any texturing despite temporary compression.

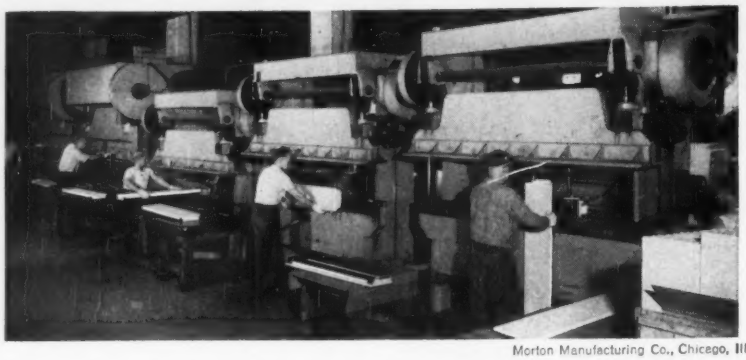
Die Lubricants and Degreasing

Any standard, light weight die lubricant may be used in forming or drawing Clad-Rex vinyl-metal laminate. However, water soluble or silicone base lubricants are recommended. Slip sheets of heavily waxed paper have also been used quite successfully.

White gasoline or a mild detergent is recommended for removing heavy grease. CAUTION: Trichlorethylene vapor degreasers or chlorinated solvents will adversely affect the vinyl to metal bond. With this exception, the vinyls and adhesives used in Clad-Rex laminates are practically impervious to acids, alkalis and other chemicals.

Bending, Shearing, Drilling, and Punching

Clad-Rex vinyl-metal laminates will withstand normal metal forming operations without damage. Using standard combination roll formers, Clad-Rex can be processed into Pittsburg locks, 90 or 180 degree crimp bends, double ogee and crimp rolls without vinyl rupture or delamination.

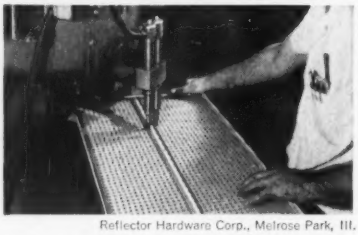


Morton Manufacturing Co., Chicago, Ill.

Clad-Rex will also withstand normal cutting operations. However, where possible, the vinyl side of the laminate should be exposed to the cutting edge. When using Clad-Rex laminated on both sides, the thinner gauge vinyl should be exposed.

Assembly and Fastening

Clad-Rex vinyl-metal laminate subassemblies can be fastened much like any unfinished sheet metal piece-parts



Reflector Hardware Corp., Melrose Park, Ill.

except for resistance welding. Here, projection welding techniques are most practical if the vinyl surface of weld area will be a finish surface.

The equipment required for suitable result must (1) be tooled for series welding (both electrodes on same side of sheet), and (2) be capable of very short weld times and extremely fast follow-up of forging pressures.

Epoxy resins are proving quite successful for assembly. Clamps can be eliminated by using resistance weld tacking or interlocking design.

Plating and Rust Proofing

All metal used in Clad-Rex vinyl-metal laminates is bonderized. However, Clad-Rex vinyl-metal laminates can be supplied with a variety of organic coatings on the metal underside. Or, Clad-Rex can be laminated on both sides.

After fabrication, Clad-Rex can be cadmium plated to protect all exposed edges, if required. These same edges can be sprayed or roller coated with vinyl paint as well.

A Source of Engineering Service

Clad-Rex interest in helping you extends into your own plant. A Clad-Rex Fabricating Engineer is provided to show your production people how easy it is to process Clad-Rex.

Furthermore, Clad-Rex operates a fully staffed and equipped research laboratory. Its facilities are devoted to customer service as well as improving Clad-Rex itself.

Write and describe your product. See how Clad-Rex can work its broad effect on your product.

VINYL-METAL LAMINATES BY CLAD-REX® DIVISION OF SIMONIZ COMPANY

2105 Indiana Avenue • Chicago 16, Illinois

Telephone: VIctory 2-7272

"What you don't know about grinding wheels makes an important difference"

Elden L. Auker, Marketing V. P. of Bay State Abrasives, is a man who knows the industry through years of experience both in working in the field with Bay State customers and from close association with the research and development programs at Bay State's manufacturing headquarters in Westboro, Mass.

"It's a sad but proven fact that all grinding wheels are *not* the same... even when they *look* the same and, in many cases, even when they have the same general specifications.

"The fact that many of our wheels are safer, faster-cutting and more efficient than their competitors is a tribute to our research and development people... who have led the world in such important abrasive developments as REINFORCED RAISED HUB DISC-WHEELS, GRIT-CLOTH, HIGH SPEED SNAGGING WHEELS, DURACUT...and whose latest developments promise to give even greater reality and meaning to our long-established 'Wheels of Progress' trademark.

"To show you specifically what I'm talking about, let's take a look at some of the current research and product quality projects under way at Westboro . . ."

NEW IDEAS, NEW TECHNIQUES for better grinding at lower cost...

"A completely new approach to the manufacture of honing stones is in the works. It starts with a unique, atmosphere-controlled kiln which promises more perfect uniformity of honing stone performance than has ever been possible before. The process winds up with tests under actual production conditions, as shown above. Technician Arthur Taylor is running a vertical honing machine which is one of the very few such test machines—and may well be the only one—devoted solely to research use by an abrasive manufacturer. Tests run on this machine show up the smallest weaknesses and inconsistencies of texture, stone-hardness, etc., and these are weeded out so that production stones are uniform in every respect."

BAY STATE

BAY STATE
WHEELS of PROGRESS

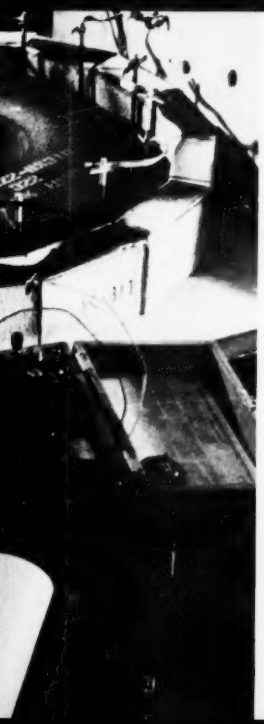
"Better grinding at lower cost to you – that's our business . . . and that's what you see in the making here on these pages. We start with good ideas . . . but only the best ever pass our ruthless tests."

Elden L Anker

BAY STATE VICE PRESIDENT,
MARKETING

"Sure, thermal tests are unspectacular but they're brutal just the same. Here a snagging wheel is placed in a heat chamber and peripheral surface is heated just as it would be in normal use . . . only more severely, by far. Thermocouples are imbedded into the side surface and here you see James McElroy checking the temperature gradient from periphery to center. Extreme differential between outer and inner temperatures eventually cracks wheels and only formulations with outstanding resistance to thermal cracking are ever put into production."

"Our vacuum mixing is a very critical process and Bay State leads in designing production machinery that ensures completely bubble-free material for honing stones. High vacuum in the mixing chamber forces even tiny bubbles out of the mix and rigid temperature control further guarantees uniformity of consistency. A technician is shown here pouring abrasive grain into the mixer preparatory to adding fluid bond material."



"Breaking the sound barrier? Well, you might think so when Bay State's new hot-pressed, high-speed snagging wheels are tested to destruction. Locked inside a huge steel drum, the big wheels are whirled at ever-increasing speed until they literally explode under the tremendous centrifugal stresses imposed. No wheel is put into production unless tests prove that it has at least a 4 to 1 safety factor. Bay State snagging wheels are now safety-rated at higher speeds than current grinders can produce. That's technician Clement Gareri removing shattered fragments of a wheel that burst into smithereens at one of the highest surface speeds ever recorded in the industry."

"Tensile strength, plus!
Figure-eight briquette samples of snagging wheel material are gripped in steel jaws and placed in a machine capable of exerting a direct pull of 50,000 lbs. Under the monstrous tensile loads imposed, even rock-hard snagging wheel material stretches before it breaks and the tests immediately show up formulations that resist tensile loads most effectively . . . and are therefore safest for use."

"Increased automation of vitrified wheel production helps speed up customers' orders by eliminating many time-consuming steps. Conveyors deliver mix to the press line where each press has its own, automatic drying oven. Here, Factory Superintendent Richard Thompson checks the formula and other special instructions for a particular job as operator Henry Bouvier carefully weighs out the correct amount of mix. That's the drying oven in the background and the press at right. This largely automated set-up is virtually unique in the industry."

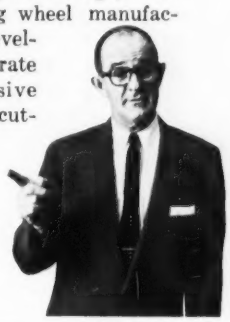
"Petrographic Microscopy may be a jawbreaker but it's vital to effective grinding. Research Ceramist Irvin Havens here checks the relationship between abrasive grain and bond in a very hard wheel. Another project of his is to determine the importance of grain *shape*. If sufficiently improved performance can be gained by sorting abrasive grains for shape as well as size . . . Bay State wheels of the future will incorporate this additional refinement."

"What's a Sonic Grader? It's an electronic nightmare as far as I'm concerned. But to an expert like Bay State's Manager of Quality Assurance, Roy Leaman, it's an extremely advanced but very worthwhile device that helps give Bay State wheels an extra edge over competition. The wheel is excited by a gentle tap and the resultant tone, or frequency of vibration, is picked up by the microphone (lower right). The operator compares this frequency with a series of electronically generated notes until he has a perfect match. The result gives a more perfect matching of wheel formulations, when re-orders of particular wheels are required."

"Bay State's **QUALITY CONTROL** programs mean better grinding at low cost for you!"

"Measuring the air flow through the side of a cut-off wheel gives us an accurate check on wheel density. This test, being conducted here by Quality Control Manager James Gilman and Louis Silvestry, is made after pressing but before baking. Twenty four carefully distributed check points are tested so that the entire wheel is covered.

To the best of my knowledge, we're the only grinding wheel manufacturer to have developed such an accurate and comprehensive density-test for cut-off wheels."



"'Samson's Hair' for reinforced disc-wheels?

What helps make Bay State disc-wheels so strong and so safe? It's the fiberglass reinforcement fabric, of course, but like Samson's hair, it has to be protected and one of Bay State's most jealously guarded secrets is the composition of the protective resin used for that purpose. This coating was the first and is still by far the best resin that successfully prevents crushing of the glass fibers during the manufacturing process. Here, Research Director Dr. H. Nathan Stone and Research Chemist Donald Grubba inspect a sample of fabric that has been removed from a *finished* wheel by burning away the bonding material in an electric furnace. The fibers are completely undamaged."

BAY STATE ABRASIVES

BAY STATE WHEELS of PROGRESS

Bay State Abrasive Products Co., Westboro, Massachusetts.
In Canada: Bay State Abrasive Products Co., (Canada) Ltd., Brantford, Ontario.
Branch Offices: Chicago, Cleveland, Detroit, Los Angeles, Pittsburgh. *Distributors:* All principal cities.

DURA-PLATE INCREASES DURABILITY OF CHROME-PLATED PARTS BY OVER 50%

Dura-Plate, the new Brown-Lipe-Chapin process, gives chrome-plated parts a new dimension in durability.

New Dura-Plate consists of a duplex nickel base *plus* a thicker layer of crack-free chromium. Two-thirds of the initial layer is semi-bright nickel which is columnar in structure. The remaining one-third layer is bright nickel with a laminar structure. On top of this is a layer of chromium up to five times normal thicknesses. Together these three elements provide a higher degree of resistance to corrosion than has ever been achieved by conventional processes.

After 18-hour CASS Tests and actual field surveys with Dura-Plated parts, results showed that these parts resisted corrosion up to 50% more than companion parts plated by conventional methods.

The brilliance of Dura-Plate plus its outstanding resistance to corrosion adds important sales advantages to consumer products and opens up new applications for chrome-plated parts.

OUTDOOR LIVING: Dura-Plated parts can withstand the rigors of the most severe climate conditions, making it ideal for outdoor furniture, grilles, and outdoor-living accessories.

APPLIANCES: The lustrous brilliance of Dura-Plate parts provide extra sales appeal to ranges, refrigerators, toasters, washers and dryers. Grease detergents and other household cleaning agents will not mar the beauty of parts plated with Dura-Plate.

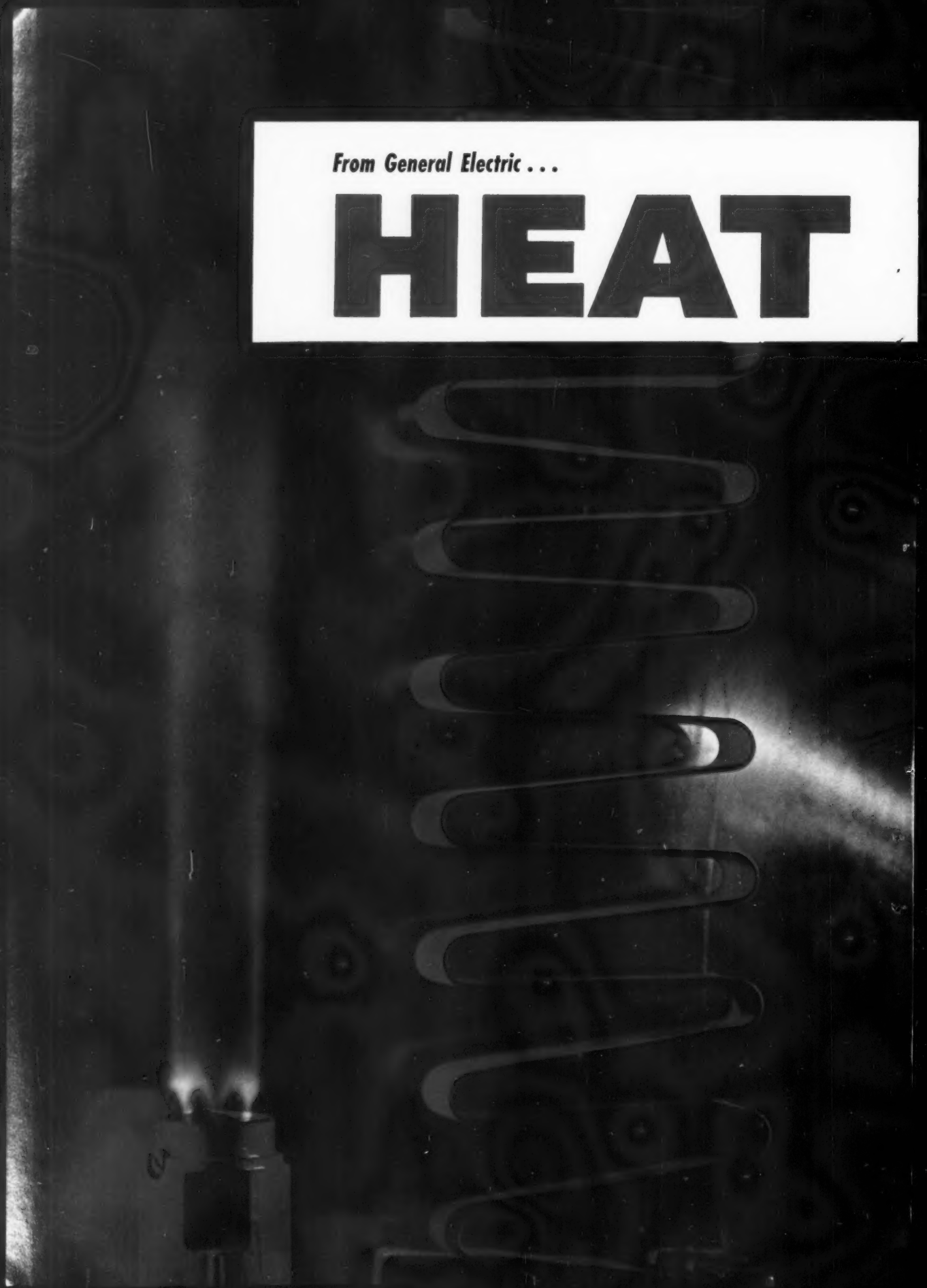
AUTOMOTIVE: Sparkling trim of Dura-Plate will stand up under the punishment of salt, snow and water, providing longer lasting protection for the beauty of automotive bright work.

In addition to Dura-Plate, Brown-Lipe-Chapin offers mass production facilities for die casting, all metal stampings, anodizing, rolled sections, polishing and painting. For further information, call or write Brown-Lipe-Chapin, Syracuse, New York.

GM GENERAL MOTORS

RELIABILITY by BROWN·LIPE·CHAPIN

DIVISION OF GENERAL MOTORS CORPORATION


From General Electric . . .
HEAT

with complete atmosphere control

GENERAL ELECTRIC OFFERS NEW ATMOSPHERE PRODUCERS FOR ELECTRIC AND GAS FURNACES

A complete line of new General Electric Exalene, Neutralene, Thermalene, and Ammalene atmosphere producers are available in "packaged" units. They're pre-piped, pre-wired and pretested to simplify and speed installation. And these attractive G-E producers give you ease and economy of operation and maintenance . . . measures of General Electric dependability.

G-E atmosphere producers can save you money . . . in production costs, because protective atmospheres prevent oxidation and decarburization. Costly machining is eliminated, and your product's quality is often improved. Material cost is less since you can produce your own low cost substitutes for hydrogen and nitrogen.

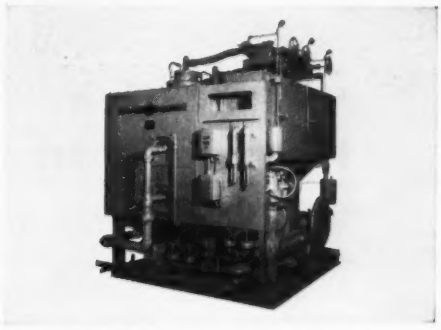
Flexibility, another money saving General Electric feature, provides for adjustment and control of the gas composition . . . you get just the mixture you need for the application.

When you purchase General Electric protective atmosphere equipment, you get the right equipment properly installed. And you can be sure that expert General Electric engineers, and service facilities are as near as your phone.

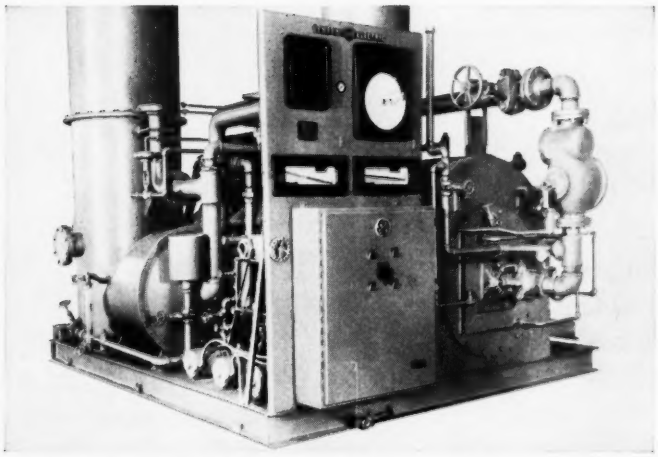
For more information, contact your nearby G-E Apparatus Sales Office, or write Section 721-27, General Electric Co., Schenectady 5, New York.

GENERAL ELECTRIC

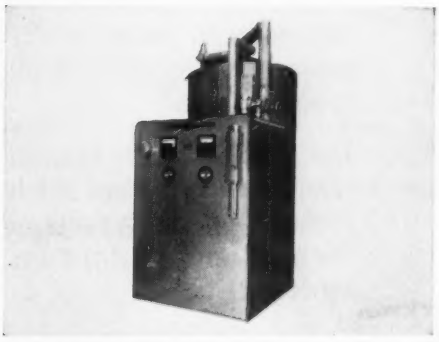
EXALENE PRODUCER for exothermic gas, lowest cost, most widely used gas, to 30,000 cfh.



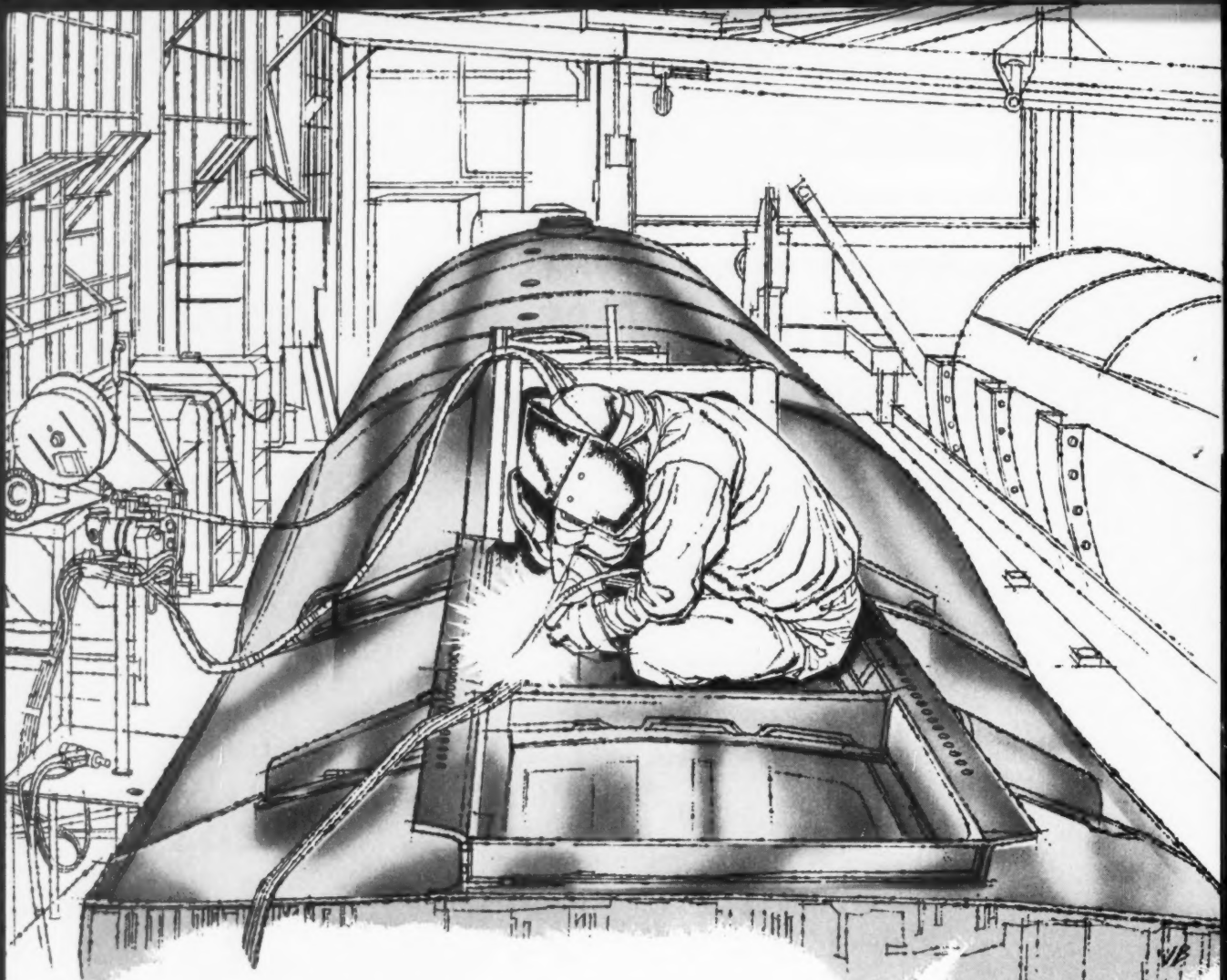
THERMALENE PRODUCER for endothermic gases to 3600 cfh with minimum of maintenance.



NEUTRALENE PRODUCER for purified exothermic gas. This economical G-E equipment available to 20,000 cfh. Also available with CO removal equipment.



AMMALENE PRODUCER for low-cost, high-purity hydrogen substitute to 8000 cfh.



Formula for Success

The formulation of a stainless steel alloy requires as much precision as any chemical compound. All the care exercised in the selection of a particular alloy can be nullified by variations in the analysis specified.

During fabrication, for example, slight differences in chromium-nickel: carbon ratios can cause changes in microstructure which lead to early failure.

That's why it is safer to specify J&L Consistent Quality Stainless Steel. J&L leads the industry in melt shop standards for stainless steel—the point where quality starts, **and longer service life begins.**

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STAINLESS
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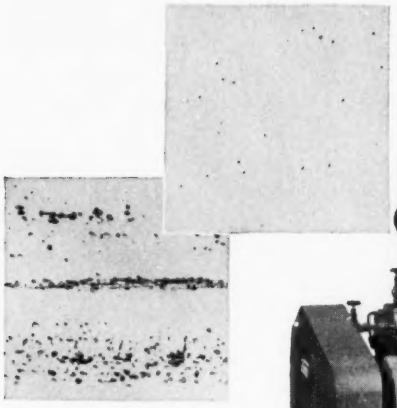
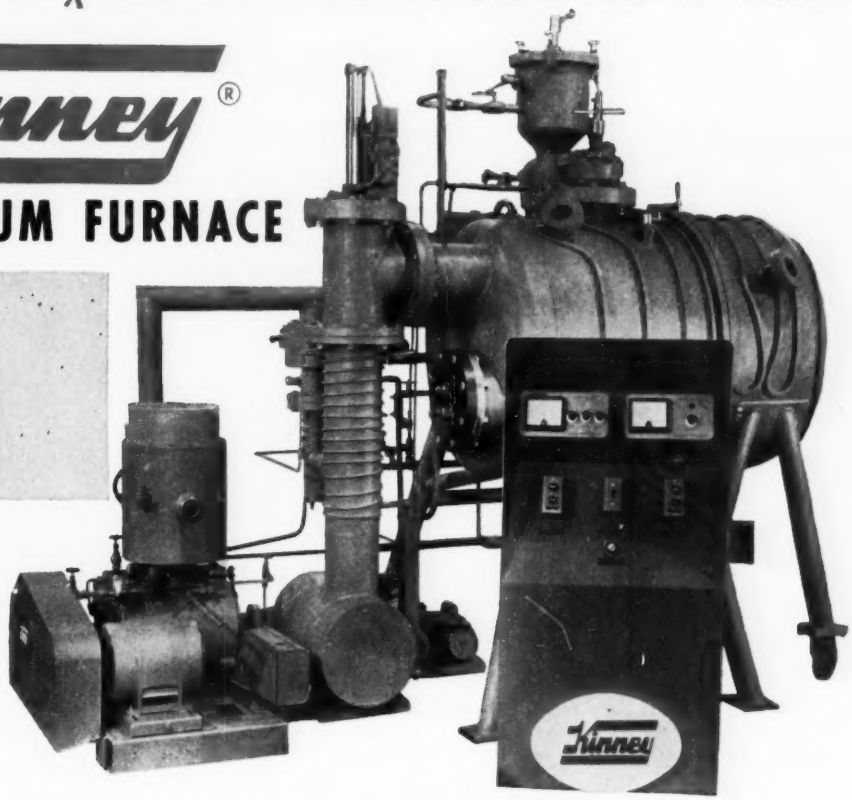
Jones & Laughlin Steel Corporation • STAINLESS and STRIP DIVISION • Box 4606, Detroit 34

perfect

MELT AND CAST PIECES UP TO 50 POUNDS IN THIS—

Kinney® HIGH VACUUM FURNACE





Above—Cross section of vacuum molded billet. *Below*—The same metal but cast in atmosphere.

When you can't afford to let gases reduce the quality of your castings and run reject rates out of sight, the practical money-making aspects of KINNEY High Vacuum Furnaces assert themselves. The 50 pound model shown has found excellent application with high nickel steel, carbide tool steel, uranium and other metals. But, the value of this KINNEY Furnace is not confined to the more exotic metals . . . low alloy steels are dramatically improved by vacuum processing.

ADD TO MELT WITHOUT BREAKING VACUUM

You can introduce alloying material or add to the melt while maintaining a high vacuum in this versatile furnace. You can also operate the furnace using moderate positive pressure and an inert gas atmosphere.

ENGINEERED FOR PERFORMANCE

The furnace chamber features a full-opening hinged door or a rollaway type door with vertical or oblique split. Valving and special mechanisms for manual or automatic operation can be supplied and numerous accessories are available such as: various sizes of induction heating units, indexing of mold table, dip thermocouple and probe rod.

Complete your file of KINNEY High Vacuum equipment. Write for new Bulletins on Furnaces for Sintering, Annealing, Degassing, Brazing and Heat Treating.

AT THE METALS SHOW... VISIT THE KINNEY BOOTH... Get the facts on what's new in High Vacuum

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Please send us your latest literature on KINNEY High Vacuum Furnaces and KINNEY High Vacuum Pumps and Accessories.

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Protecting downcomers with a heat-resistant concrete lining made with **Atlas Lumnite Cement**

A heat-resistant concrete lining, being gunited in place, solves the problem of abrasion in this blast-furnace downcomer system. Made with Lumnite calcium-aluminate cement and aggregates, this smooth, jointless concrete lining will withstand the abrasive attack of particles in the gas stream – extending the life of the steel structure.

In new installations or repairs, monolithic linings are easily and economically placed – by guniting, casting or troweling. Unit downtime is reduced because concrete reaches service strength in 24 hours.

Other applications in blast-furnace systems include foundation pads, blast main linings, stove domes and other areas where resistance to heat and corrosion are required.

For convenience, castables bonded with Lumnite cement are available from leading manufacturers of refractories. These are packaged mixtures, ready for use by adding only water. For more information, write Universal Atlas, 100 Park Avenue, New York 17, New York.

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Universal Atlas Cement
Division of
United States Steel

OFFICES: Albany · Birmingham · Boston · Chicago · Dayton · Kansas City · Milwaukee · Minneapolis · New York · Philadelphia · Pittsburgh · St. Louis · Waco

Choose the key that unlocks the door to profits

● Your profit picture begins with the design and engineering of your plant. It is the purpose of the McKee organization to see that it doesn't end there.

Sound engineering before the first shovelful of dirt is turned can mean initial savings in construction and repeated savings in plant operation—savings that go on year after year.

The experience and skill demonstrated by McKee engineers in steel, petroleum and chemical plant design and construction totaling more than $1½ billion promises a cost-cutting, efficient operation. If you have plans for such construction McKee has the key for you.

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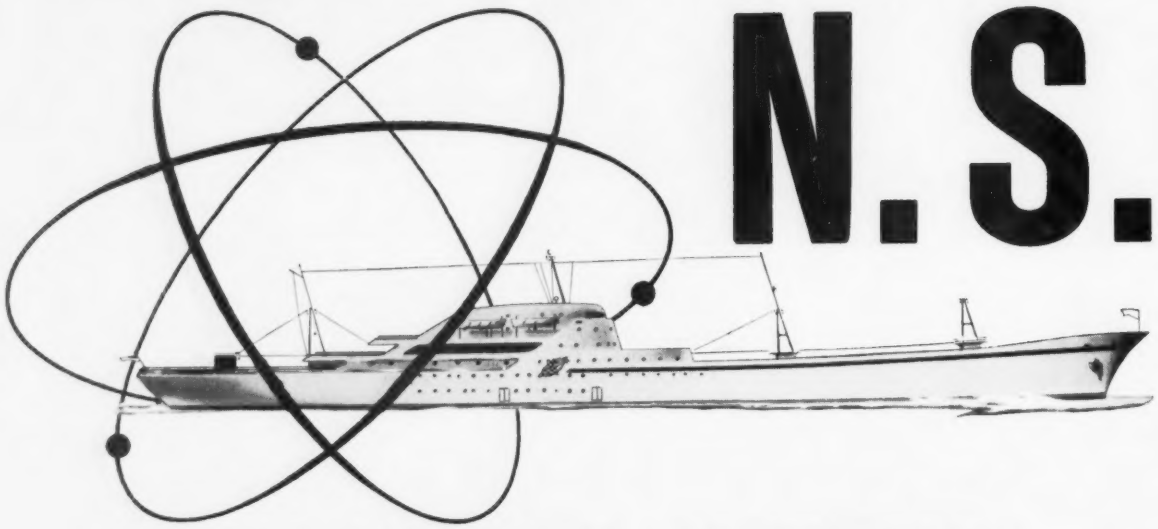
McKEE ENGINEERING AND CONSTRUCTION SERVICES



Equipped with 61,240 lbs. of REVERE 70/30 Cupro-Nickel Condenser Tubes in main propulsion unit... Tube Sheets also Revere

NEW REVERE WELDING GUN USED IN INGERSOLL-RAND CONDENSERS, THE FIRST TUBE TO TUBE SHEET WELDED CONDENSERS FOR MARINE SERVICE.

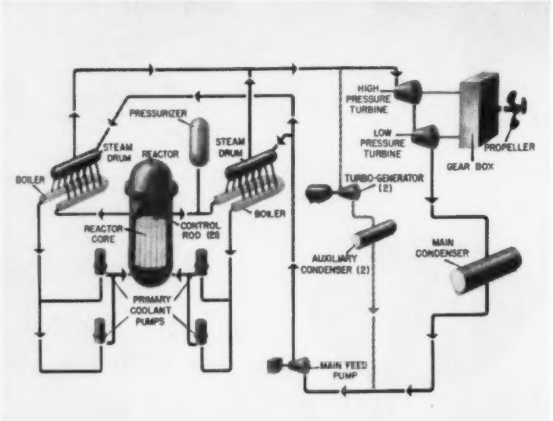
The N.S. Savannah is more than a first in the annals of maritime history. For this "Ship of Peace" will carry the message of "Atomic Energy for Peaceful Pursuits" around the world. Its ability to travel some 300,000 nautical miles during an estimated 3½ year period without refueling is a shining example of the ingenuity of modern science and the resourcefulness of American Industry.

From scores of cities throughout the United States came the elements that went to make the whole . . . elements that had to be assembled with the precision of a watch. From Ingersoll-Rand, Phillipsburg, N. J., came the condensers. To make those condensers operate at sustained efficiency tube sheets and tubes of 70/30 Cupro-Nickel were specified. The sheets were rolled at Revere's New Bedford Plant while 61,240 lbs. of Revere 70/30 Cupro-Nickel Condenser Tubes came from Rome, N. Y.

REVERE WELDING GUN USED TO OBTAIN SOUNDEST POSSIBLE JOINTS

And, to guard against the possibility of even the slightest leaks where tubes join tube sheets, the newest, most effective welding technique was used, employing the Revere Automatic Welding Gun. (See photo right.) Through this Revere method the tube and tube sheet become integral. Such reliably sound joints guard against the danger that sea water (which contains destructive chlorides) might contaminate the feed water. Even the smallest amounts could cause serious damage to the nuclear power plant.

The use of these excellent Revere materials and advanced Revere techniques goes far to insure the dependability of the condensers in this revolutionary new ship. For original installations or re-tubing—ashore or aboard ship—it pays to take advantage of Revere's products and experience. Call Revere today.



REVERE COPPER AND BRASS INCORPORATED

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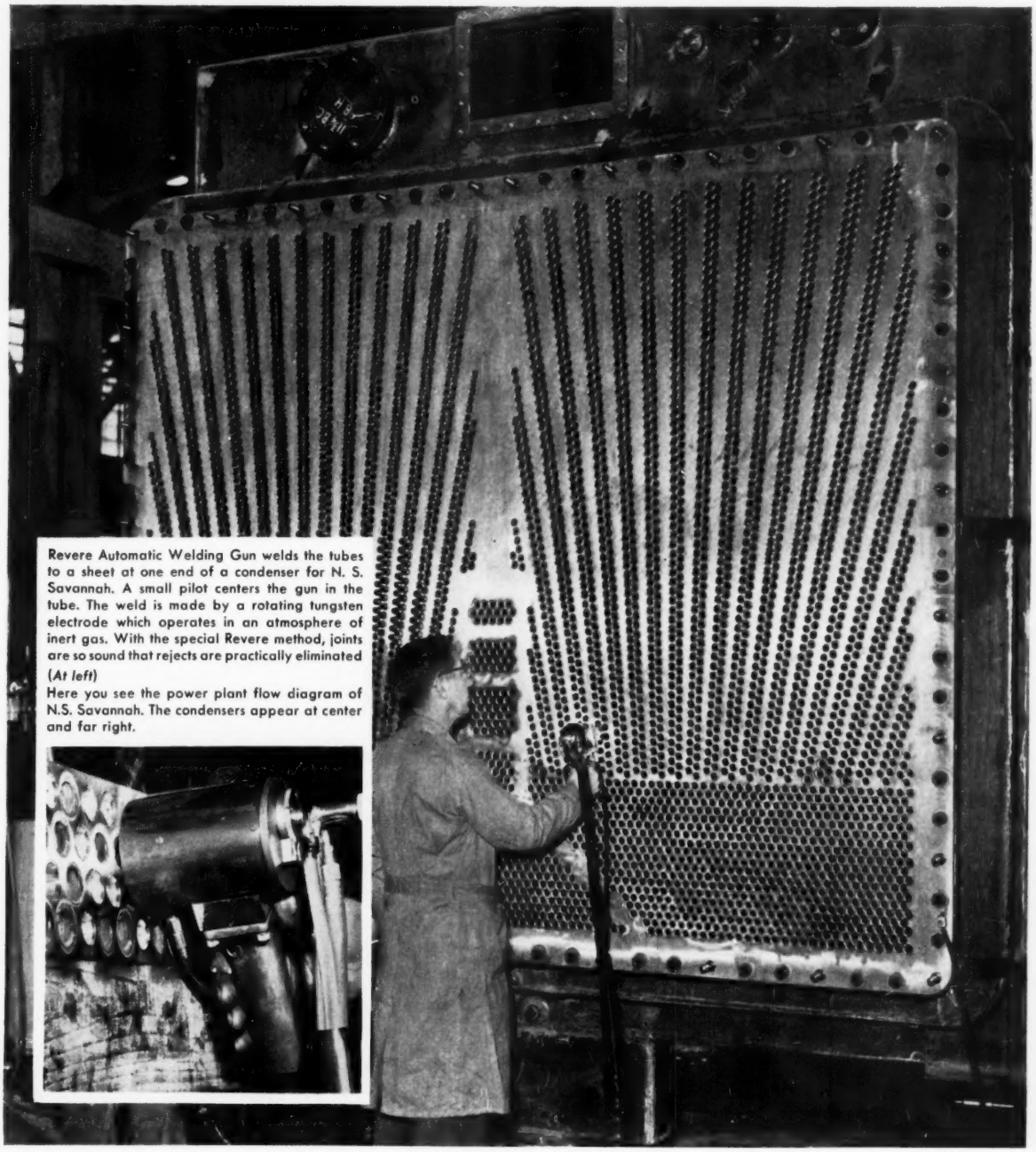
New York 17, N. Y.

Mills: Rome, N.Y.; Baltimore, Md.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles, Riverside and Santa Ana, Calif.; New Bedford, Mass.; Brooklyn, N.Y.; Newport, Ark.; Ft. Calhoun, Neb.; Sales Offices in Principal Cities, Distributors Everywhere.

SAVANNAH

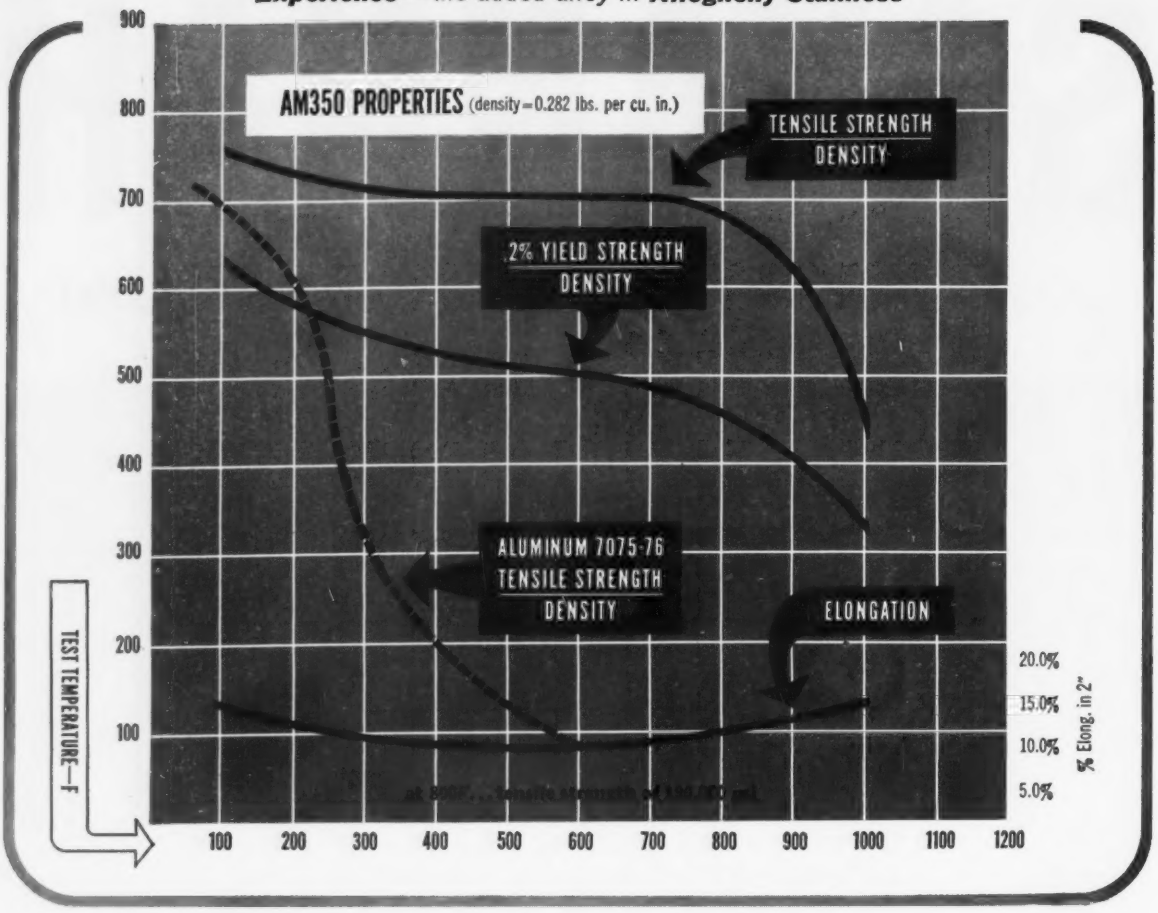
World's first nuclear-powered merchant vessel



Revere Automatic Welding Gun welds the tubes to a sheet at one end of a condenser for N. S. Savannah. A small pilot centers the gun in the tube. The weld is made by a rotating tungsten electrode which operates in an atmosphere of inert gas. With the special Revere method, joints are so sound that rejects are practically eliminated

(At left)
Here you see the power plant flow diagram of N.S. Savannah. The condensers appear at center and far right.

Experience *— the added alloy in* ***Allegheny Stainless***



Two for the space age—AL's AM-350 and AM-355 precipitation hardening steels

A unique combination of highly desirable properties describes Allegheny Stainless AM-350 and AM-355 Steels. They combine high strength at both room and elevated temperatures, excellent corrosion resistance, ease of fabrication, low temperature heat treatment, good resistance to stress corrosion.

They are proving the answer to many space age problems. Airframe and other structural parts, pressure tanks, power plant components, high pressure ducting, etc. are all natural missile and supersonic aircraft applications for AM-350 and AM-355.

AVAILABILITY: AM-350, introduced several years ago, is available commercially in sheet, strip, foil, small bars and wire. AM-355, best suited for heavier sections, is available commercially in forgings, forging billets, plates, bars and wire.

CORROSION RESISTANCE: Compared to the more familiar stainless grades, AM-350 and AM-355 resist corrosion and oxidation better than the hardenable grades (chromium martensitic) and only slightly less than the 18 and 8's. They resist stress corrosion at much higher strength levels than do martensitic stainless grades.

SIMPLE HEAT TREATMENT: High strength is developed by two methods. Both minimize oxidation and distortion problems. The usual is the Allegheny Ludlum-developed sub-zero cooling and tempering (SCT): minus 100F for 3 hrs plus 3 hrs at 850F. Alternate method is Double Aged (DA): 2 hrs at 1375F plus 2 hrs at 850F.

EASY FABRICATION: AM-350 and AM-355 can be spun, drawn, formed, machined and welded using normal stainless procedures. In the hardened conditions, some forming may be done . . . 180 degree bend over a 3T radius pin. Also AM-350 can be dimpled in the SCT condition to insure accurate fit-up.

For further information, see your A-L sales engineer or write for the booklet "Engineering Properties, AM-350 and AM-355." *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa. Address Dept. S-221.*

WSW 7816

ALLEGHENY LUDLUM

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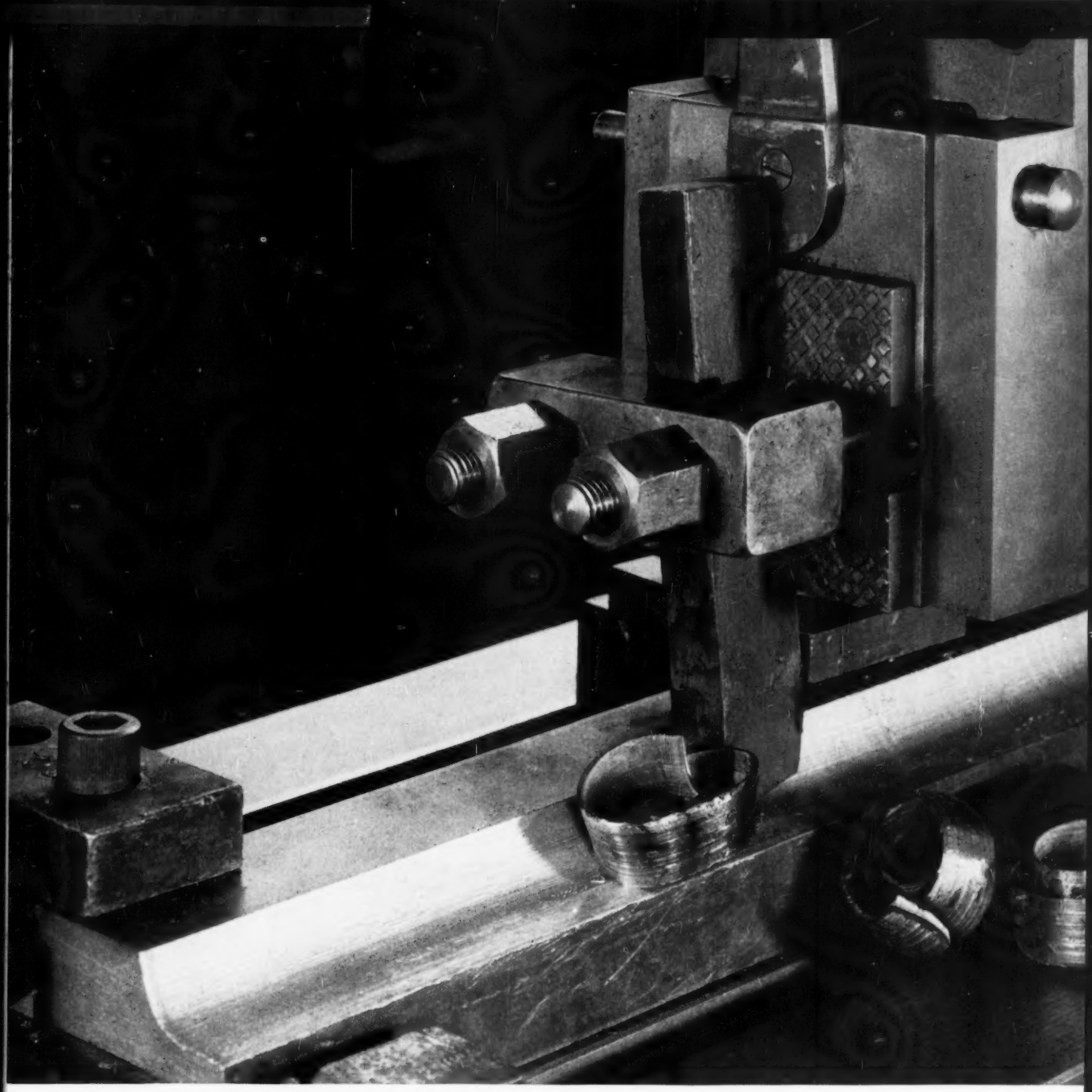
EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

AL



Machining gib for heavy duty lathe from cold rolled steel. Depth of cut: ¾"; feed: .060"

The Big Cut without the Big Cost

You can pay more, but you can't buy greater power and accuracy than is yours with a reliable Smith & Mills Shaper. In fact, even if you spend thousands of dollars more, you will not obtain all the advantages that Smith & Mills offers.

Throughout continuous high speed operation, using heavy feeds and maximum power, a Smith & Mills Shaper holds limits and resists deflection. The reasons are apparent . . . Solid Ram, unequalled for heavy duty, high production work . . . Patented Self-Locking Ram Adjustment for one-step positioning (even when reciprocating) and complete backlash elimination . . . exclusive "Solid Unit" Bull Gear Assembly . . . ram, rocker arm, bull gear and other critical components made of nodular iron.

Compare . . . feature for feature . . . cut for cut . . . cost for cost! Prove to yourself that a Smith & Mills Shaper offers all the power, accuracy and versatility of the expensive shapers, yet costs hundreds, even thousands of dollars less. Write today for details and specifications.

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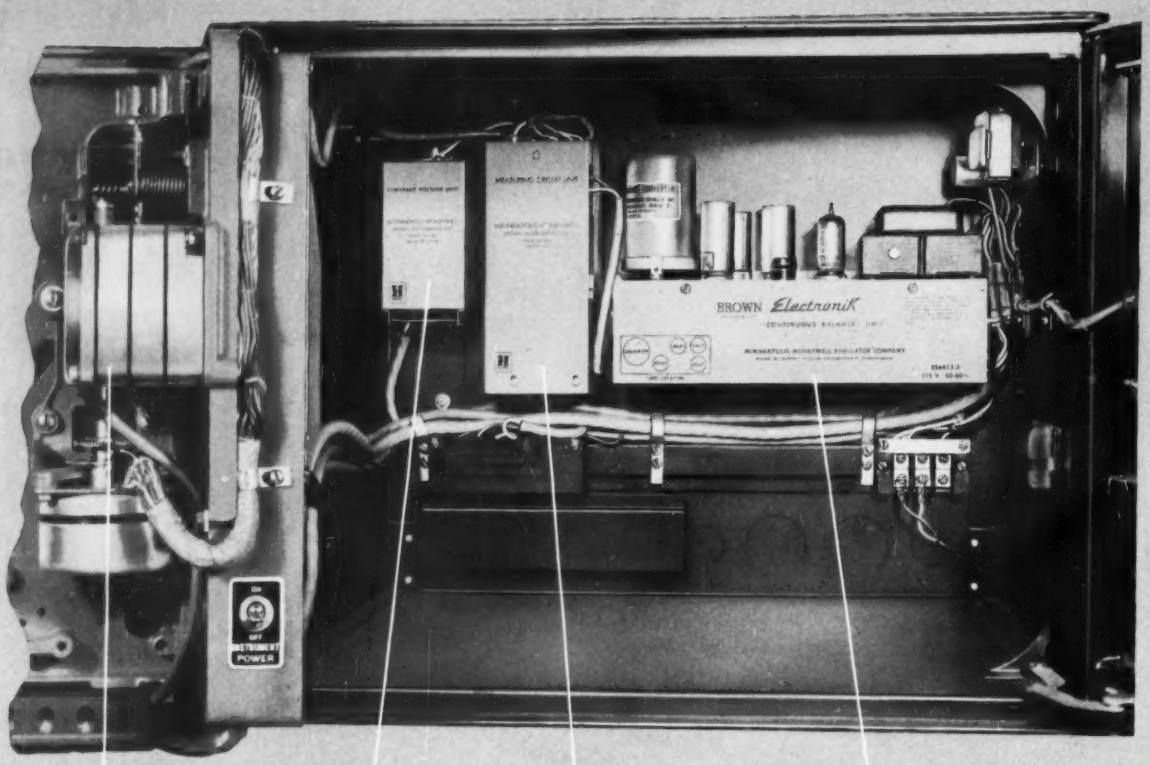
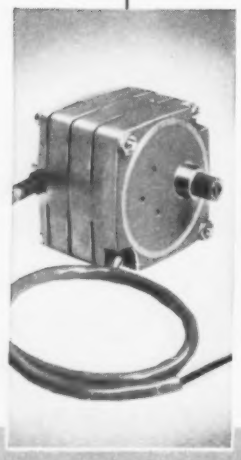
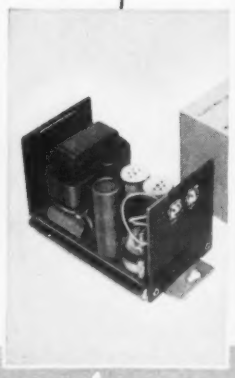
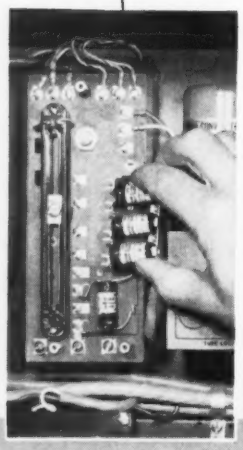




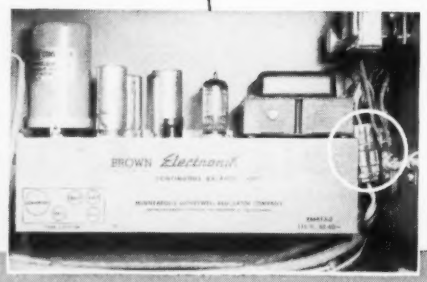
Servo Motor has sectional housing, leakproof oil wick, printed circuits for simplified servicing. Any major part can be replaced in 2 minutes.



Constant Voltage Module—Uses Zener diodes and an ambient temperature compensator to replace standardizing mechanism.



Measuring Circuit Module—Contains easily-changed range spool panels and vernier adjustment. Range is changed simply by replacing screw-clip panels of fixed resistors.



Amplifier Module—Quick-connect design permits fast, easy removal for servicing and replacement. Circle shows quick connect plug.

THESE FOUR NEW FEATURES ARE STANDARD WITH ALL *ElectroniK* POTENTIOMETERS

New modular design...

makes ElectroniK potentiometers easier to use and maintain

Now, four great new features add new operating and servicing ease to all *ElectroniK* circular and strip chart potentiometers.

- **New servo and chart drive motors are sectionalized so that any major part can be replaced in two minutes.**
- **A new constant voltage unit replaces batteries, standard cells and standardizing mechanisms.**
- **A new measuring circuit, with quick-change range spools, simplifies range changing and reduces stray pickup.**
- **A quick-connect feature lets you remove the amplifier for service and replace it quickly.**

Now, modular design is combined with the traditional precision of *ElectroniK* potentiometers, to give you a greater value than ever in accurate, dependable measurement and control.

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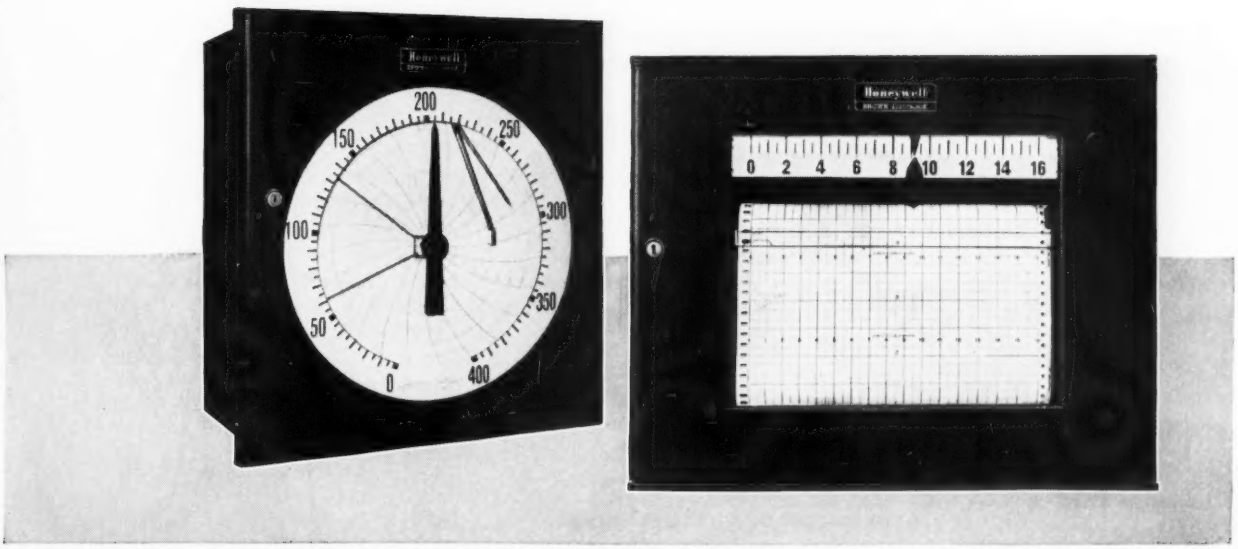

3 NEW SERIES IR SCREW DRIVERS

give you an ANNUAL DIVIDEND on your PAYROLL DOLLARS

NEW **DESIGNS**
SPEEDS
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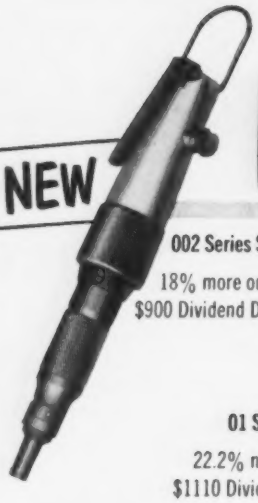

002 Series Screw Driver
18% more output . . . for
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75% more output . . . for
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If your operators are using older model screw drivers, you can increase their man-hour productivity by as much as $3750 Payroll Dollars in one year, just by replacing the older tools with one of the three new I-R designs.

Multiply these *Annual Dividends* by the number of screw driver operators in your plant, and you can see why management today is taking a new look at portable tool operations.

There's a fast, easy way to calculate the amount of *Dividend on Payroll Dollars* these new I-R screw drivers can help you earn in just one year—without adding to your present payroll.

It's yours without obligation. To get it, call your I-R AIRengineer today. Or write Ingersoll-Rand, 11 Broadway, New York 4, N. Y.

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Tools plus AIRengineering increase output per man

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Using this microphotometer, Jessop can detect and measure the per cent of even trace elements in a sample of specialty steel.

"How Jessop reads your specialty steels!"

—C. M. Carlisle, DIRECTOR OF ANALYTICAL CHEMISTRY

"If you're ever near the Jessop plant, stop in and ask for a tour through our chemical laboratories.

"There you'll see how Jessop makes certain you get the exact per cent of alloying elements specified for your specialty steel.

"For example, you'll see a *microphotometer* — that's what I'm peering at so intently in the above photograph!

"I'm studying a film showing the spectrum of a sample of steel from Jessop's No. 2 electric arc furnace. Each chemical element in this specialty steel appears as a distinct line. By reading these lines, I can detect even minute *traces* of elements and after some simple calculations, determine the per cent of each."

This modern chemical laboratory is one more reason why you get your specialty steel tailor-made to your order . . . and you get it on time. **Specify Jessop . . . and then relax!**

VMA 6719

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STEEL COMPANY
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SULFURIC ACID
Standard: 60° and 66° Baumé, 99% H_2SO_4
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NITRIC ACID
Diamond: 36°, 38°, 40°, and 42° Baumé
Strong Nitric Acid, 95% and fuming grades
Photo-Engravers' Grade
Reagent, ACS

MURIATIC (Hydrochloric) ACID
18°, 20° and 22° Baumé, Standard, Diamond, Crystal and Reagent Grades

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Anhydrous, Aqueous 70%, and Reagent

PHOSPHORIC ACID
Wet Process, 65% and 75%, Com'l and Fertilizer Grades
Food Grade, 75%
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Varying proportions of Nitric and Sulfuric Acids to meet customers' requirements

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For 60 years, General Chemical has been the nation's primary producer of heavy acids. General has its own basic raw material sources. Its production facilities include 21* sulfuric plants, 4* hydrofluoric plants, 3 nitric and 3 muriatic acid plants. It operates one of the nation's largest fleets of tank cars, tank trucks and acid-carrying barges, and distributes from key points coast-to-coast. General's production, transportation, service and sales facilities are geared to meet your requirements best, both in quality of product and dependability of service. Write or phone today for information or service.

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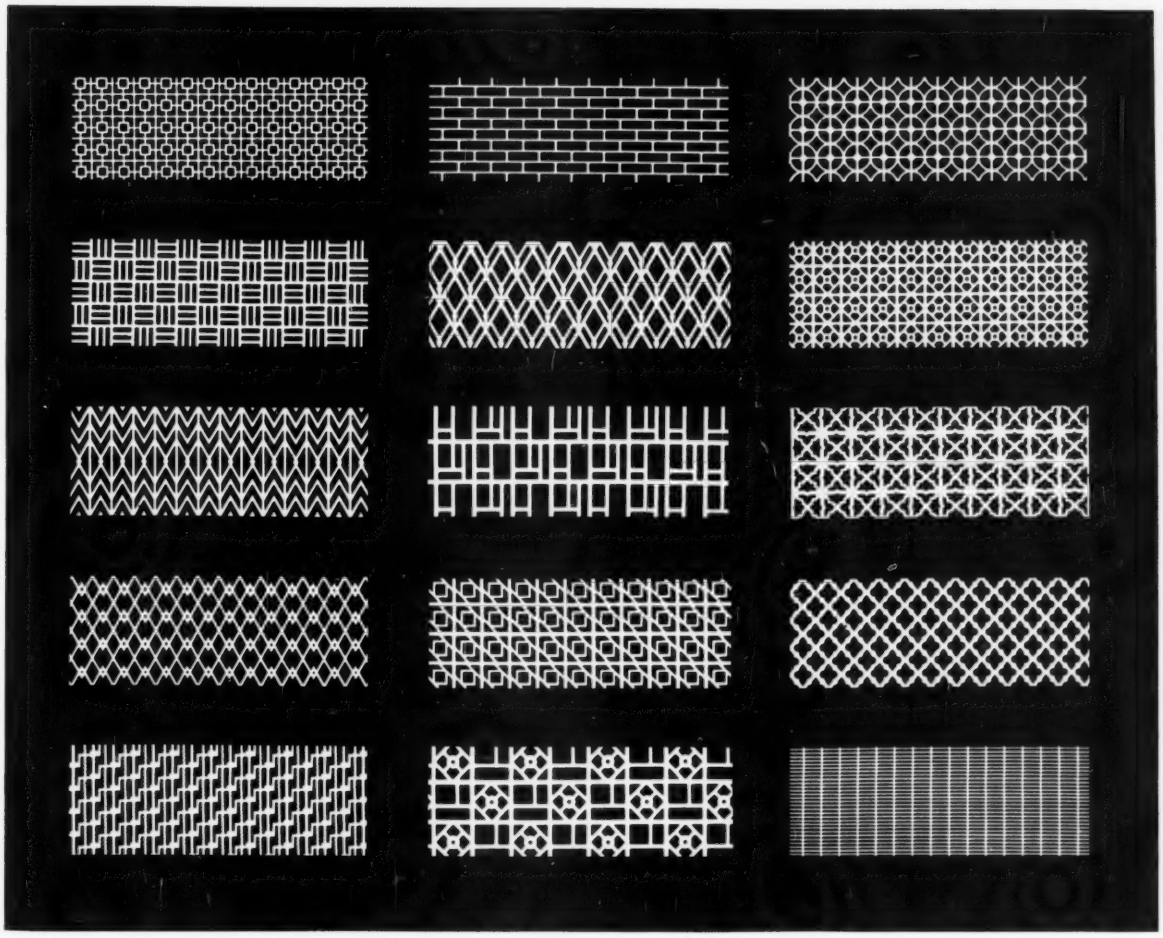

Why Metalworkers Work With Hendrick Perforated Metal

For well over 80 years the metalworking industry has relied on Hendrick for its perforated metal requirements. And with good reason! Hendrick perforated metal combines decorative beauty with the functional strength so often called for on new product specifications. Hendrick's vast stock of dies includes over 100 unusual patterns that are exclusive and only obtainable from the Hendrick Manufacturing Company.

Hendrick perforated plate is available in every type of commercially rolled metal in gauges and sizes of perforations to meet your exact specifications. For more information call your nearby Hendrick sales office. It's listed in your classified telephone directory under Metals, Perforated. Or—for FREE booklet, mail the coupon, today.

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☐ Have representative call.

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Mitco Open Steel Flooring • Shur-Site Treads • Armorgrids • Hydro Dehazers • Distillation Column Internals

CRANE WITH ROTATING TROLLEY SPEEDS WAREHOUSE HANDLING

Storage area for tubing used in the production of tapered roller bearings at The Timken Roller Bearing Company, Bucyrus, Ohio. A Cleveland Tramrail double-girder completely motorized crane handles the material in and out of storage and to the machine tools. The crane can travel the entire length of the department and the trolley will rotate 360 degrees, enabling the operator to turn full bundles into position required for loading machine racks.

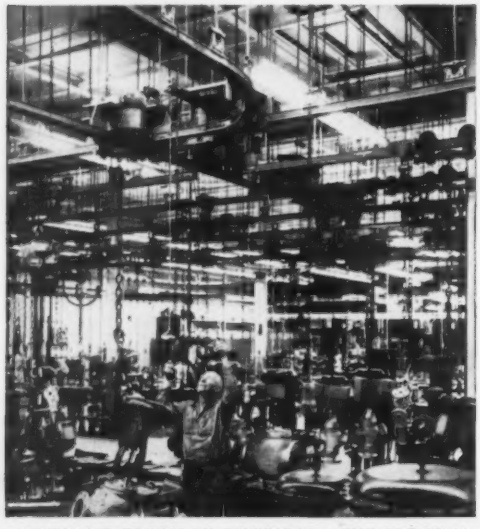
CLEVELAND TRAMRAIL USED IN MANY WAYS TO PRODUCE IMPORTANT SAVINGS

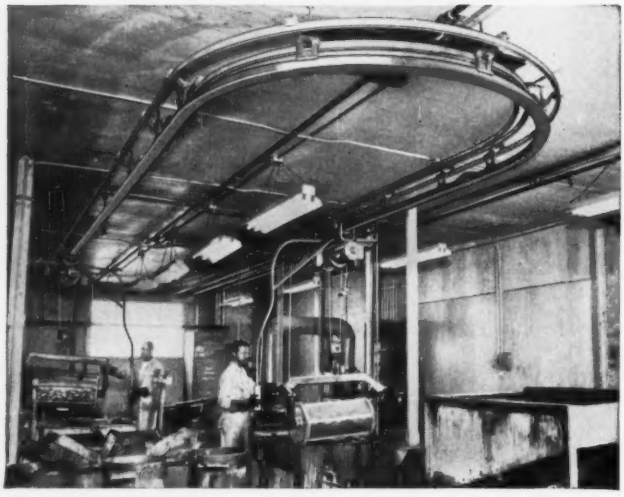
TRAMRAIL SYSTEM HANDLES VALVES THROUGH VARIOUS STEPS OF MANUFACTURE

Provides 80% Floor Space Savings

This is not a blurred picture. What makes it appear so is the vast number of chains suspended from hundreds of Cleveland Tramrail carriers which are used at the Mason-Neilan Division, Worthington Corporation, Norwood, Massachusetts, to carry valves through the various steps of manufacture. The entire system of production is dependent upon the performance of the overhead Tramrail.

A very important advantage of the Tramrail system is the large savings in floor space it makes possible. If floor type handling equipment were used, it has been estimated that about five times as much floor space would have been required.





TRAMRAIL TRACK LOOP CUTS CLEANING AND PLATING COSTS

This Cleveland Tramrail track loop at the Duro Fittings Co., Los Angeles, California, is a big factor in cutting costs and speeding parts between cleaning and plating operations. Two hand-operated carriers with electric hoists serve this work at high efficiency.

WRITE FOR FREE COPY of Engineering and Data Booklet No. 2008. Packed with valuable information. Profusely illustrated.

CLEVELAND TRAMRAIL

Overhead Materials Handling Equipment

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80-ton trailer hauls 5 times its own weight!

built from USS MAN-TEN and USS "T-1" Steels

LeTourneau-Westinghouse designed this bottom dump hauling unit to carry the greatest payload with the least possible empty weight. The trailer weighs just over 15 tons but will haul a whopping load of 80 tons or more. This gives it an extremely high ratio of payload to weight and makes the unit most economical on fuel, tires and other operating cost items.

The trailer was built with USS MAN-TEN High Strength Steel in the body and USS "T-1" Constructional Alloy Steel in the highly stressed rear-axle assembly. This combination produced a tough wear-resisting unit that would take the beatings from coal or rock or whatever had to be hauled.

MAN-TEN Brand Steel combines a strength level of 50,000 psi yield point min. with superior abrasion resistance. "T-1" Steel was used because its extra high yield strength (100,000 psi minimum) resulted in a lighter weight unit which would still take the road shocks at 40 miles per hour. Both steels saved weight and resulted in a payload increase of 10 tons over conventional construction.

For low hauling costs, build equipment with USS Design Steels . . . MAN-TEN for strength with economy, COR-TEN for strength with superior atmospheric corrosion resistance, TRI-TEN for strength with notch toughness and "T-1" for extra high yield strength and impact abrasion resistance. For more information, write to United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

USS, MAN-TEN, COR-TEN, TRI-TEN and "T-1" are registered trademarks

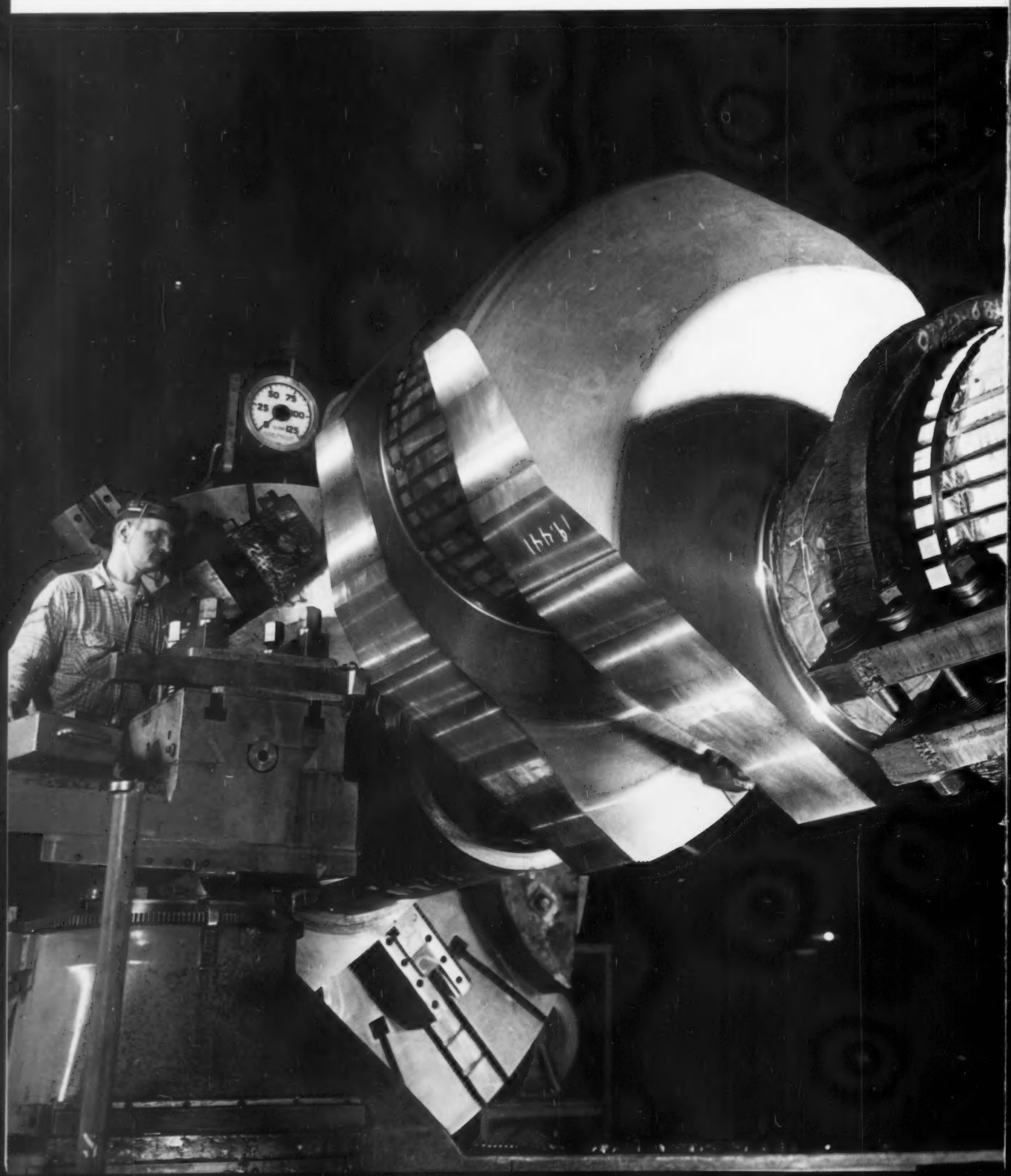
Mr. Big hauls as much coal as 1½ railroad cars but weighs less than most 50-ton capacity trucks. USS Design Steels make the difference.

USS

United States Steel Corporation—Pittsburgh
American Steel & Wire—Cleveland
National Tube—Pittsburgh
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Supply—Steel Service Centers
United States Steel Export Company

United States Steel

"60 tons of counterweights de-shimmied this shaft"



says A. H. McGurk, USS Machine Shop Foreman

Arthur H. McGurk has supervised a lot of uncommon machining jobs during his 30 years in the Forgings Division of U. S. Steel. But even he talks about this one:

It's a 30-ton single throw crankshaft for a vertical extrusion press. The German company making the press says that it's the biggest one-piece crankshaft of its kind ever made—more than 15′ long and almost 36″ in diameter at the main bearing journals. The "throw" section is about 31″ deep, and here, the crankpin journal is *42″ in diameter.*

We forged and machined this unusual shape from *one piece of steel*—a 110″ diam.-476,000# ingot of Ni-Cr-Mo-V steel that was double normalized and tempered to develop a tensile strength level of 120,000 psi. When the smooth-forged shaft was ready for machining on a 120″ lathe it weighed 72 tons, and it created a real problem. As it stood, the forging couldn't be turned on the lathe because the heavy throw section was off-center from the line of the main shaft. This eccentricity would tear the shaft from the lathe.

The problem was solved with three specially designed counterweights that totaled 60 tons. Collars were welded to the weights and they were bolted to the shaft so that it could be turned on either of its two centers without any whip. On a lathe and a planer-miller, the shaft was machined to tolerances of .001″.

Bearing surfaces were polished to a 63-microinch finish.

The rest of the machinery for this extrusion press was made in Germany, but U. S. Steel received the order for the crankshaft because the forging and machining demanded equipment and know-how that can't be matched anywhere else in the world. We'd appreciate your inquiries or requests for our free 32-page booklet about USS Quality Forgings. Just write United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania. *USS is a registered trademark*

United States Steel Corporation—Pittsburgh
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Export Company

United States Steel

USS

Here is one of a fleet of forty Type 430 Stainless Steel tank cars that transport nitric acid. Built in 1956 by General American Transportation Corporation, these tank cars are still in excellent condition.

Leading the pure life—in USS Stainless Steel

A manufacturer's *second* biggest disappointment is to have his product rejected because it was contaminated during shipment. The *biggest* disappointment comes when the customer buys his next order from someone else.

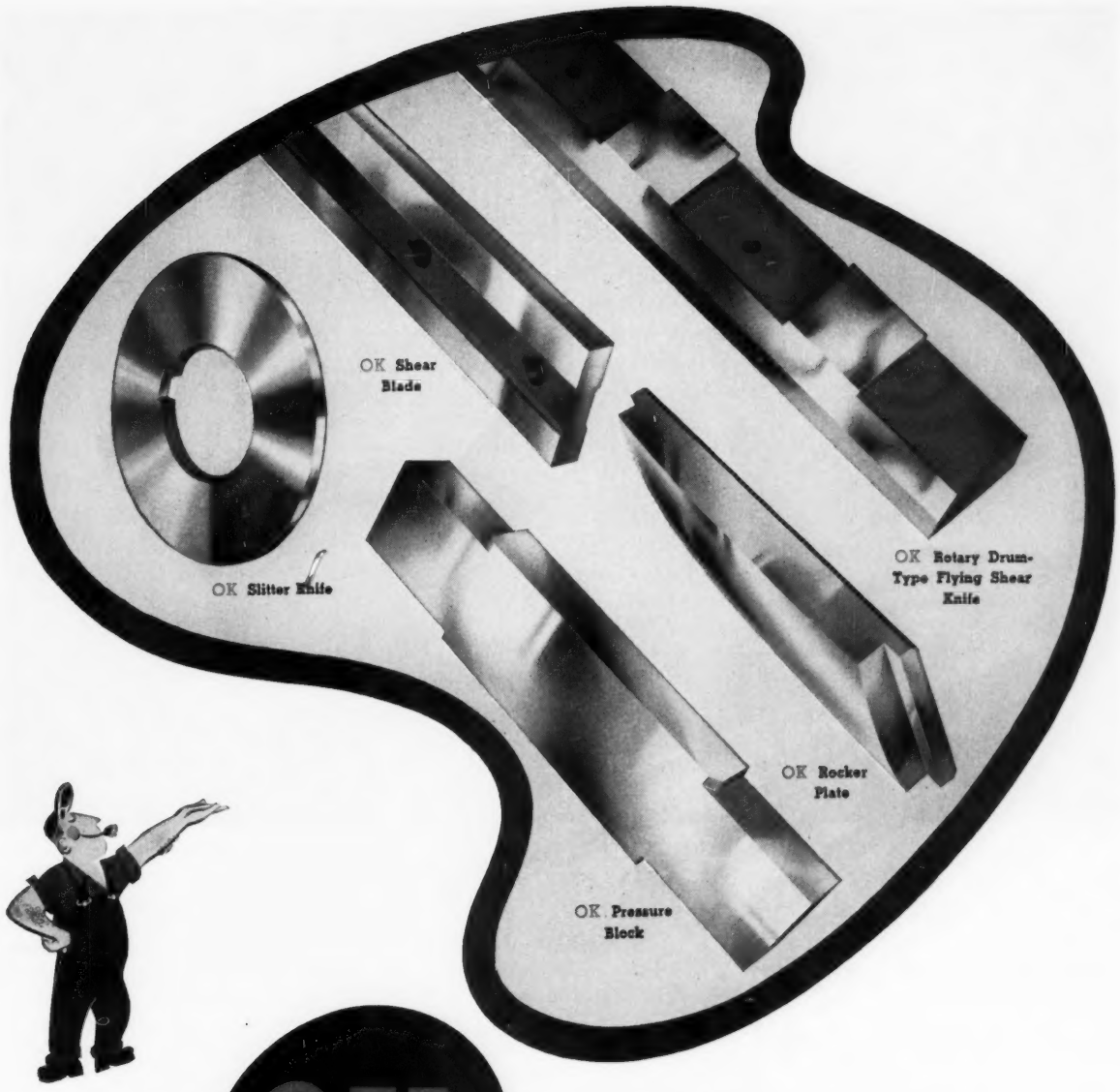
Manufacturers who ship or contain their products in Stainless Steel seldom worry about product purity. Many chemicals that eat away other metals have no effect on Stainless Steel. It keeps a smooth, dense surface that is easy to clean. No corrosion. No pits. No place for dirt to hide. And there's less danger of spoiling one batch with residue from another.

Because Stainless Steel is so strong, it can be used in thinner, lighter gages—reducing the overall weight of the container. But the real clincher is this: even though Stainless Steel costs more, there is no cheaper material in the long run. Specify USS Stainless Steel . . . through our nearest sales office or your local Steel Service Center.

USS is a registered trademark

United States Steel Corporation – Pittsburgh
American Steel & Wire – Cleveland
National Tube – Pittsburgh
Columbia-Geneva Steel – San Francisco
Tennessee Coal & Iron – Fairfield, Alabama
United States Steel Supply – Steel Service Centers
United States Steel Export Company

USS **United States Steel**



it's OK ...let'er go!

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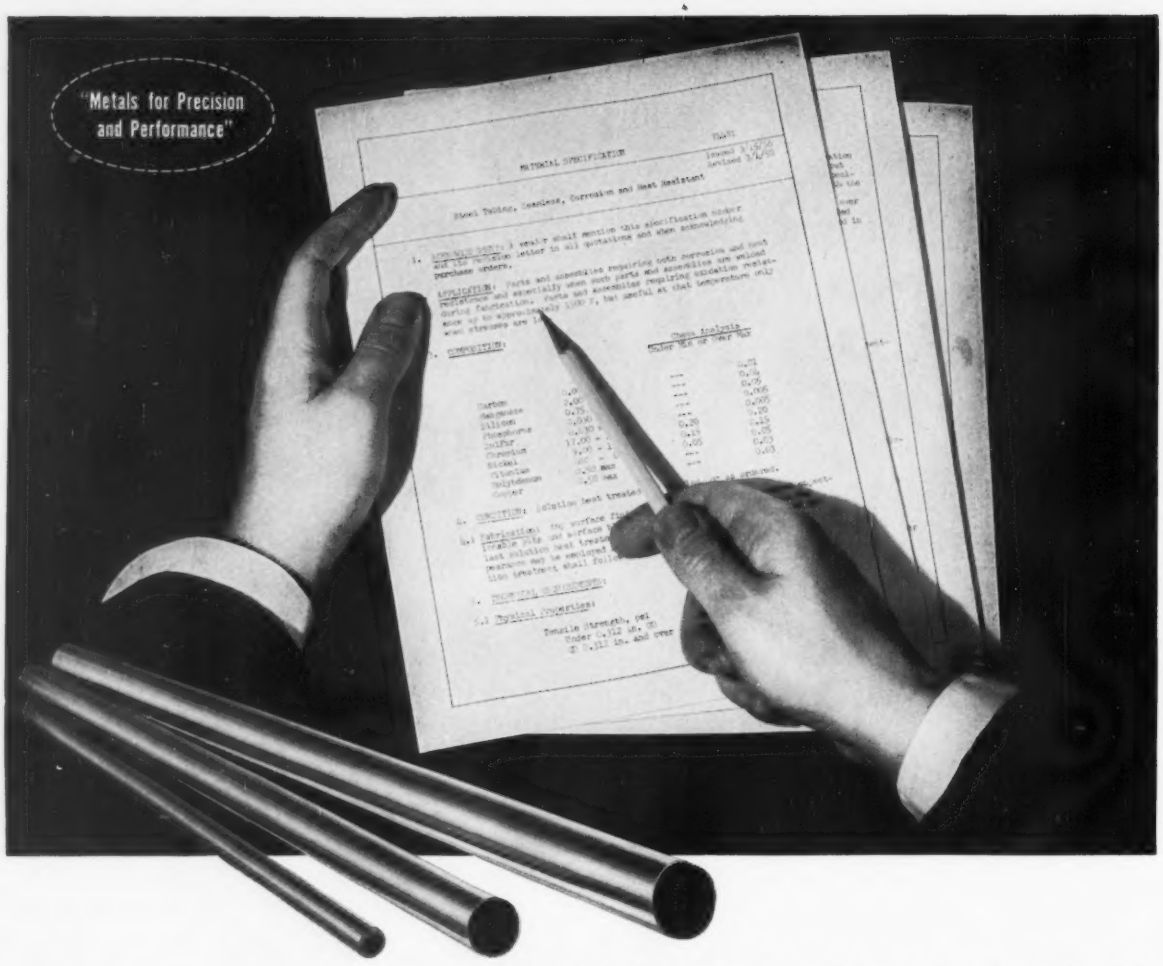


your individual tubing specs are a **BISHOP specialty**

That special tubing you need doesn't have to be a frustrating problem — BISHOP delights in tackling tough specs. BISHOP is uniquely equipped to handle specials—long on experience and capacity, short on delivery. You'll get help within 24 hours from a Quick Service Team of sales, metallurgical and production experts—and unexcelled quality tubing . . . the finest made.

Briefly, the Bishop Line . . .

STAINLESS STEEL TUBING Seamless, Welded & Drawn	Mechanical, Aircraft, Capillary, Hypodermic also NEW Stabilized and L grades, precipitation hardening alloys	0.008" to 1.000" OD 0.003" to 0.083" wall
NICKEL & NICKEL ALLOY TUBING	All standard grades	up to 1.000" OD 0.065" wall max
TUBULAR FABRICATED PARTS	Flanged, flared, milled, slotted, swaged, threaded	
GLASS-TO-METAL SEALING ALLOYS	Low expansion alloys for glass sealing applications	
CLAD METALS & COMPOSITE WIRES	Base metals & precious metals in various combinations	
PLATINUM GROUP METALS	Fabricated products—chemicals	
CATALOGS, DATA SHEETS ON THE ABOVE SENT PROMPTLY ON REQUEST		

Send in your individual specs for prompt handling, thorough analysis, prices, deliveries. Write, wire or phone NIagara 4-3100 or call your local steel service center.

AMERICAN STEEL WAREHOUSE ASS'N

Tubular Products Division

J. BISHOP & CO.

platinum works

MALVERN, PENNSYLVANIA

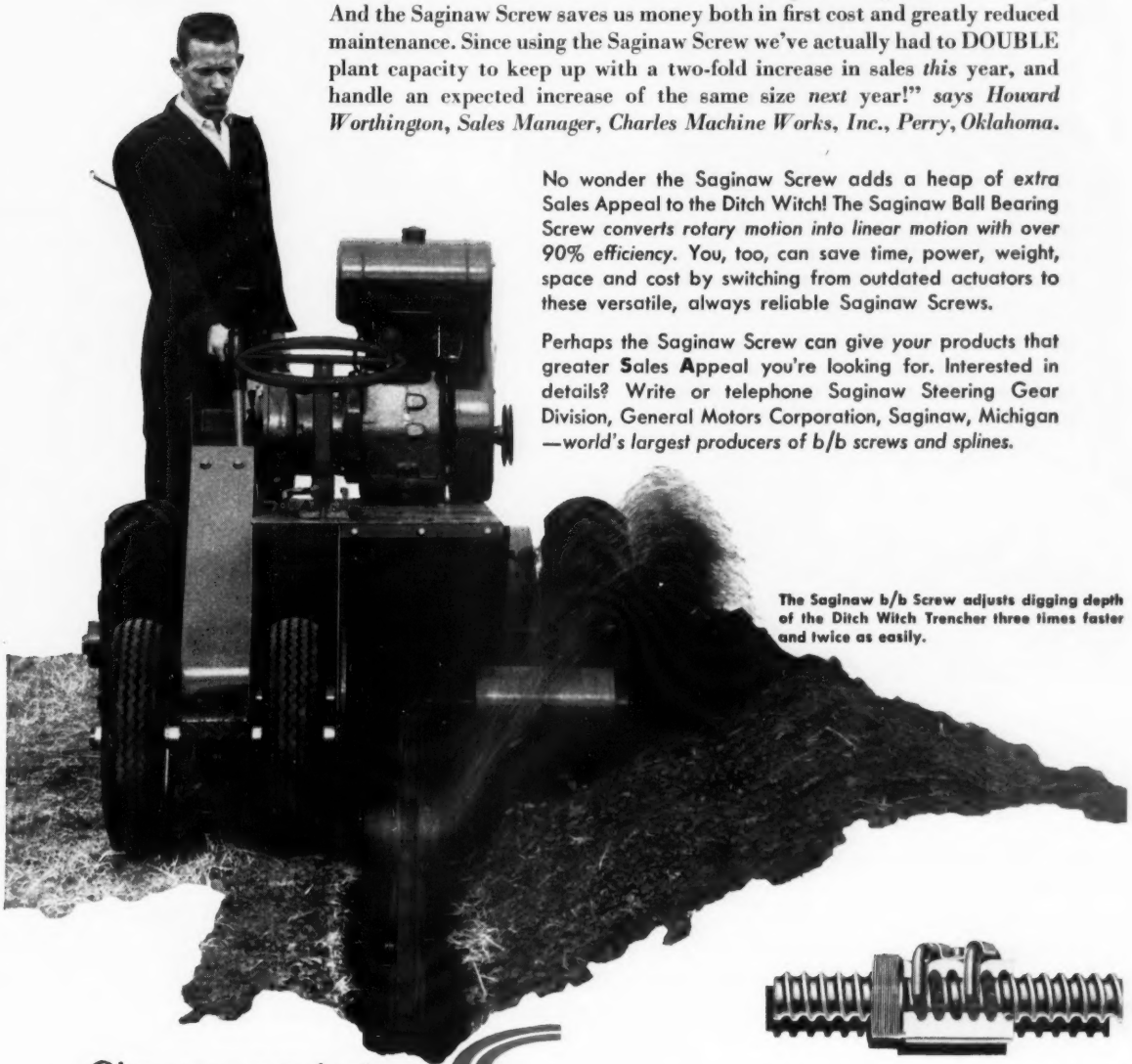
the SAGINAW b/b SCREW helps

Double Ditch Witch Sales in One Year!

"We've replaced an acme screw with a Saginaw Ball Bearing Screw to enable the digging boom of our Ditch Witch Trench Digging machine to be raised and lowered three times faster. It makes the operator's job twice as easy. And the Saginaw Screw saves us money both in first cost and greatly reduced maintenance. Since using the Saginaw Screw we've actually had to DOUBLE plant capacity to keep up with a two-fold increase in sales *this* year, and handle an expected increase of the same size *next* year!" *says Howard Worthington, Sales Manager, Charles Machine Works, Inc., Perry, Oklahoma.*

No wonder the Saginaw Screw adds a heap of *extra* Sales Appeal to the Ditch Witch! The Saginaw Ball Bearing Screw *converts rotary motion into linear motion with over 90% efficiency.* You, too, can save time, power, weight, space and cost by switching from outdated actuators to these versatile, always reliable Saginaw Screws.

Perhaps the Saginaw Screw can give *your* products that greater **S**ales **A**ppeal you're looking for. Interested in details? Write or telephone Saginaw Steering Gear Division, General Motors Corporation, Saginaw, Michigan —*world's largest producers of b/b screws and splines.*



The Saginaw b/b Screw adjusts digging depth of the Ditch Witch Trencher three times faster and twice as easily.

Give your products NEW SALES APPEAL... switch to the Saginaw ball bearing Screw

WORLD'S MOST EFFICIENT ACTUATION DEVICE

"WEIRKOTE® WON'T PEEL OR FLAKE—AND CAN END THE NEED FOR FURTHER CORROSION PROTECTION AFTER FABRICATION."

Q. A zinc-coated steel sheet that won't peel or flake, even under the severest fabricating stresses?

A. Precisely. Weirkote's made by a continuous process. The zinc is so integrated with the steel that even the toughest "torture" tests of fabrication leave that bonded coating intact. You can work Weirkote to the very limits of the steel itself!

Q. Our products are pretty intricate—take lots of flexing, crimping and so on. What about those hard-to-reach places?

A. Weirkote's zinc coating is so uniform—protects even the most complicated parts.

Q. So with Weirkote you bypass the need for further corrosion protection?

A. You get the picture! Think of the time, labor, space—the costly capital outlay—you save. Better steel products at far lower costs—that's Weirkote for you!

Send for free booklet that details the time-and-cost-saving advantages of skin-tight zinc-coated Weirkote. Just write Weirton Steel Company, Dept. B-2, Weirton, West Virginia.

WEIRTON STEEL COMPANY

WEIRTON STEEL COMPANY

WEIRTON, WEST VIRGINIA

a division of

NATIONAL STEEL CORPORATION

COMPETITIVE PRESSURES AND RISING COSTS DEMAND GREATER PRODUCTION EFFICIENCY THAN EVER BEFORE

How do you know you're making your product right?

Rather curious question, isn't it! But before you laugh it off, take a good look at what's happening on your production line. There's more processes using manufacturers than there are manufacturers using processes.

What you're looking for is efficiency. Lack of it costs money. The kind *you* pay in overhead, competitive advantage, rejects, rework operations, etc.

For example—consider your resistance welding . . .

How many spot welds are you using to assemble the piece parts of your product? . . . as many as will fit in the space? . . . enough to "be sure" it will hold? . . . or as many as *really required!* No matter how you figure it, the first two cost too much money. Because they require either too much equipment or too much time. Usually both!

Many manufacturers use resistance welding for speed. Weld integrity (which, incidentally, does not necessarily penalize speed) is often overlooked. In order to make up for lack of weld quality, more welds are used. But fifty poor welds aren't any better than fifteen poor welds. They just cost more. Particularly when five *welds of suitable quality* will do the job!

Sciaky knows that weld efficiency is a matter of combining quality with speed. That's why Sciaky equipment is precise enough to produce consistently. Once suitable quality is established, you can depend on it throughout the toughest production conditions.

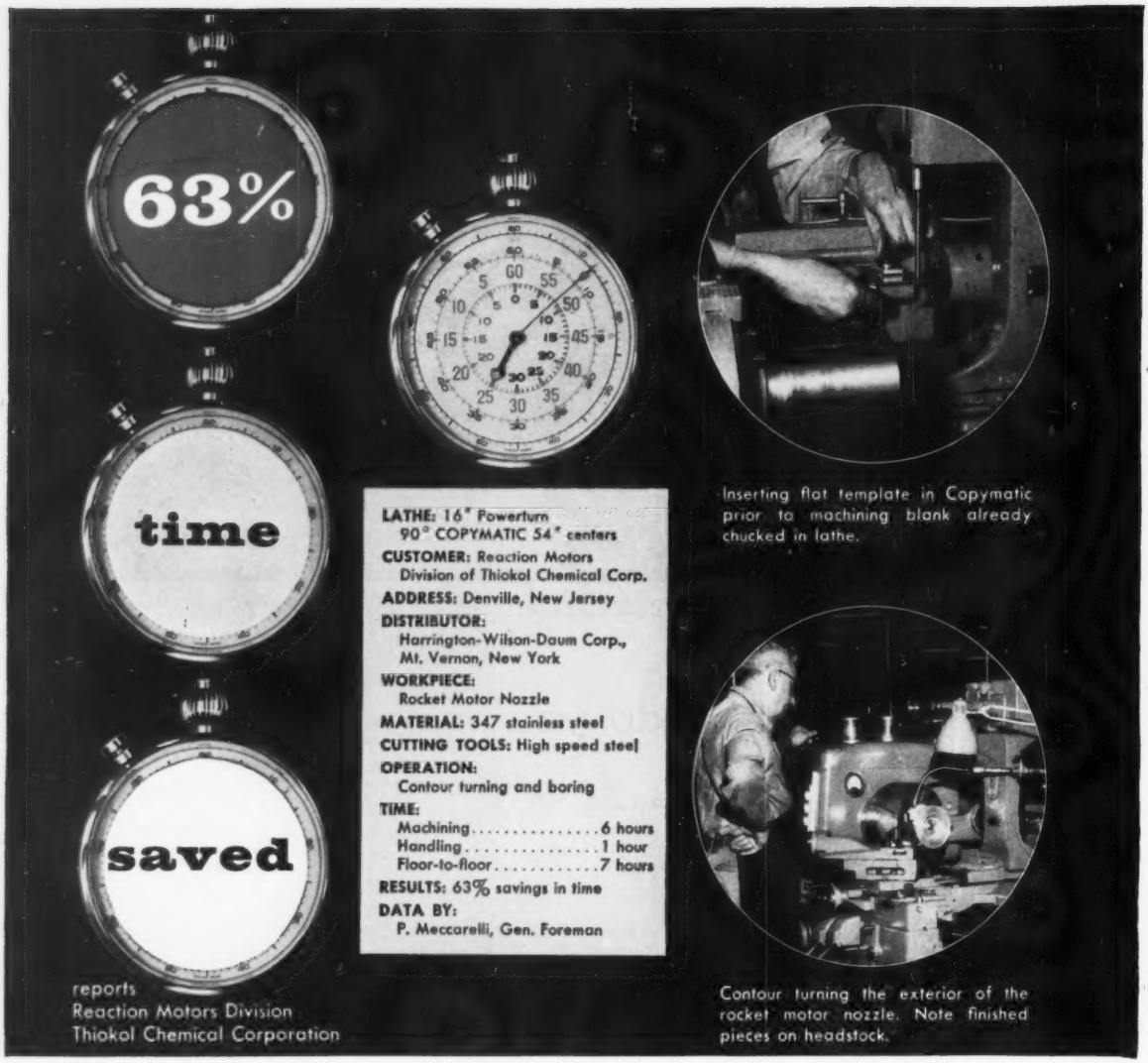
Why take less than the full advantage of consulting with a Sciaky Application Engineer the next time you're considering equipment. No obligation, of course.

The manufacturers of automobile wheels took that advantage. As a result those wheels are now being assembled with eight suitable quality welds instead of twelve rivets. Automatically. Four other operations have even been included. As a result, the wheels are better, and made faster at lower cost.

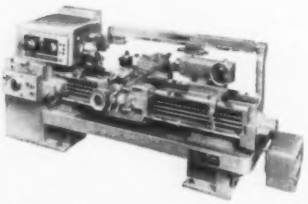
SCIAKY

74A

SCIAKY BROS., INC., 4909 W. 67th STREET, CHICAGO 38, ILLINOIS • POrtsmouth 7-5600



by this Lodge & Shipley Powerturn Copymatic Lathe



A pioneer in jet propulsion, Reaction Motors Division of Thiokol Chemical Corp., Denville, N. J., plays an important part in America's rocket defense and space exploration programs. In turn, and in turning, a Lodge & Shipley POWERTURN COPYMATIC plays an important part in rocket motor production.

In contour turning and boring a typical reaction motor nozzle, the COPYMATIC cuts 12 hours from the previous time, completing the job in 6 hours machine time and one hour handling time.

Whether you're machining the new and tougher alloys or the old stand-by metals, you'll appreciate the strength, rigidity and extra power available in Lodge & Shipley Lathes. For special jobs or routine operations, the speed and accuracy of these world famous lathes offers much to virtually any lathe user.

Investigate the time and money-saving possibilities of Lodge & Shipley COPYMATIC Lathes with 45° or 90° tracer slides. Contact your Lodge & Shipley representative or write for literature:
The Lodge & Shipley Company, 3070 Colerain Ave., Cincinnati 25, Ohio

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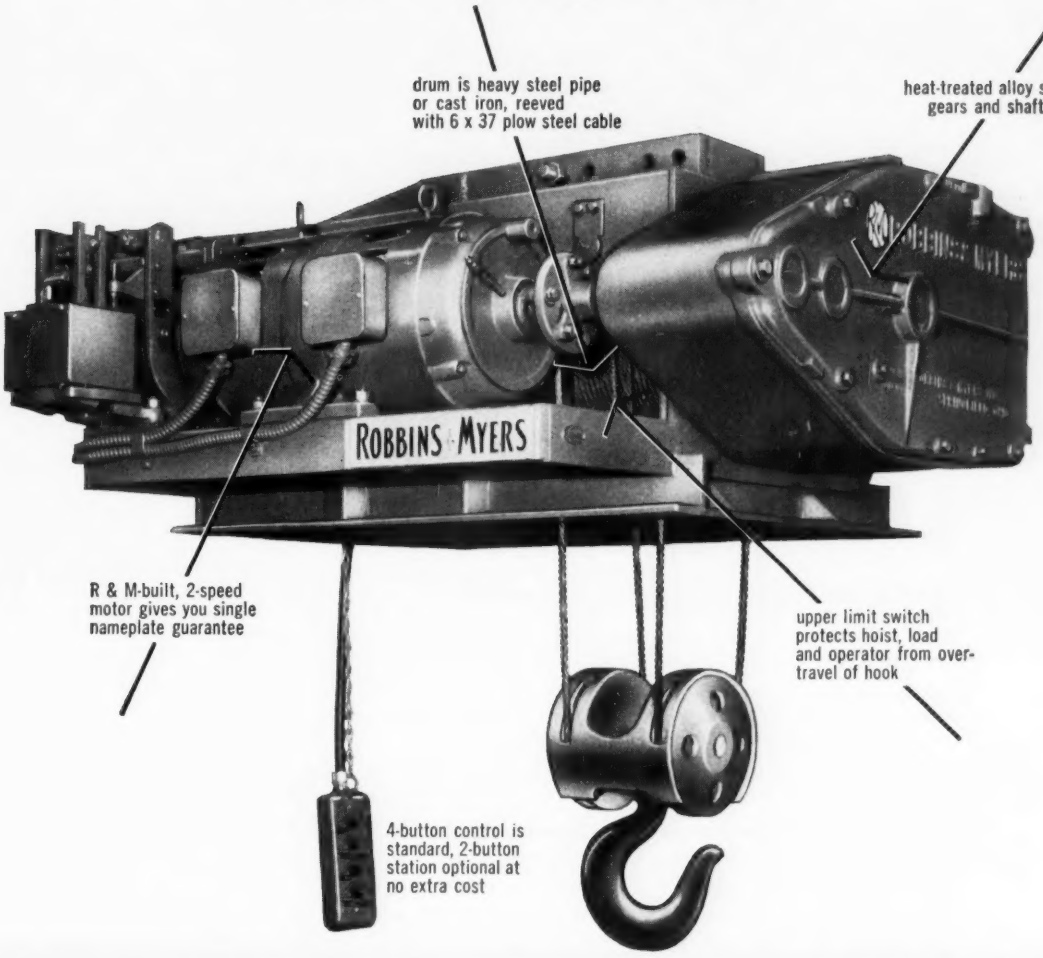
dual-duty hoist


drum is heavy steel pipe or cast iron, reeved with 6 x 37 plow steel cable
heat-treated alloy steel gears and shafts
ROBBINS-MYERS
R & M-built, 2-speed motor gives you single nameplate guarantee
upper limit switch protects hoist, load and operator from over-travel of hook
4-button control is standard, 2-button station optional at no extra cost

R&M Dual-Duty two speed hoists keep any load under complete control. They furnish the perfect, steady speed combination you need for gentle, accurate spotting of dies, cores, patterns and other delicate loads; and they give you the fast-action lifting you want for high speed production. Their simple, dependable squirrel cage motor eliminates the uncertain speed-load characteristics and maintenance problems of the slip-ring motors used on most conventional multi-speed hoists. With R & M you can select from industry's widest job-proved line: 5 frame sizes, 25 speed-load combinations.

Capacities: ½ to 10 tons. Controls: 2 or 4 pushbutton. Mounting: lug or hook; plain, geared or motorized trolleys. *Robbins & Myers, Inc., Hoist & Crane Div., Springfield, O.*

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The first—and only—service built around the most important part of your operations . . . your process requirements.

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Allied Research's long and broad experience in helping customers solve process and equipment problems of all types has led to one important conclusion:

Only by integrating equipment with your particular process are you assured of getting these important benefits from your operations: (1) higher production, (2) greater efficiency, (3) lower operating costs, (4) consistent product quality.

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CONSULTATION—Experienced representatives will assist you in properly planning any part of or all your process and equipment requirements.

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SERVICE—Field Engineers insure proper start-up and will make necessary maintenance recommendations. They are available for periodic check-up.

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The reputation of Roebling high carbon flat spring steel is based on two uncompromising facts: its unexcelled dimensional and mechanical uniformity.

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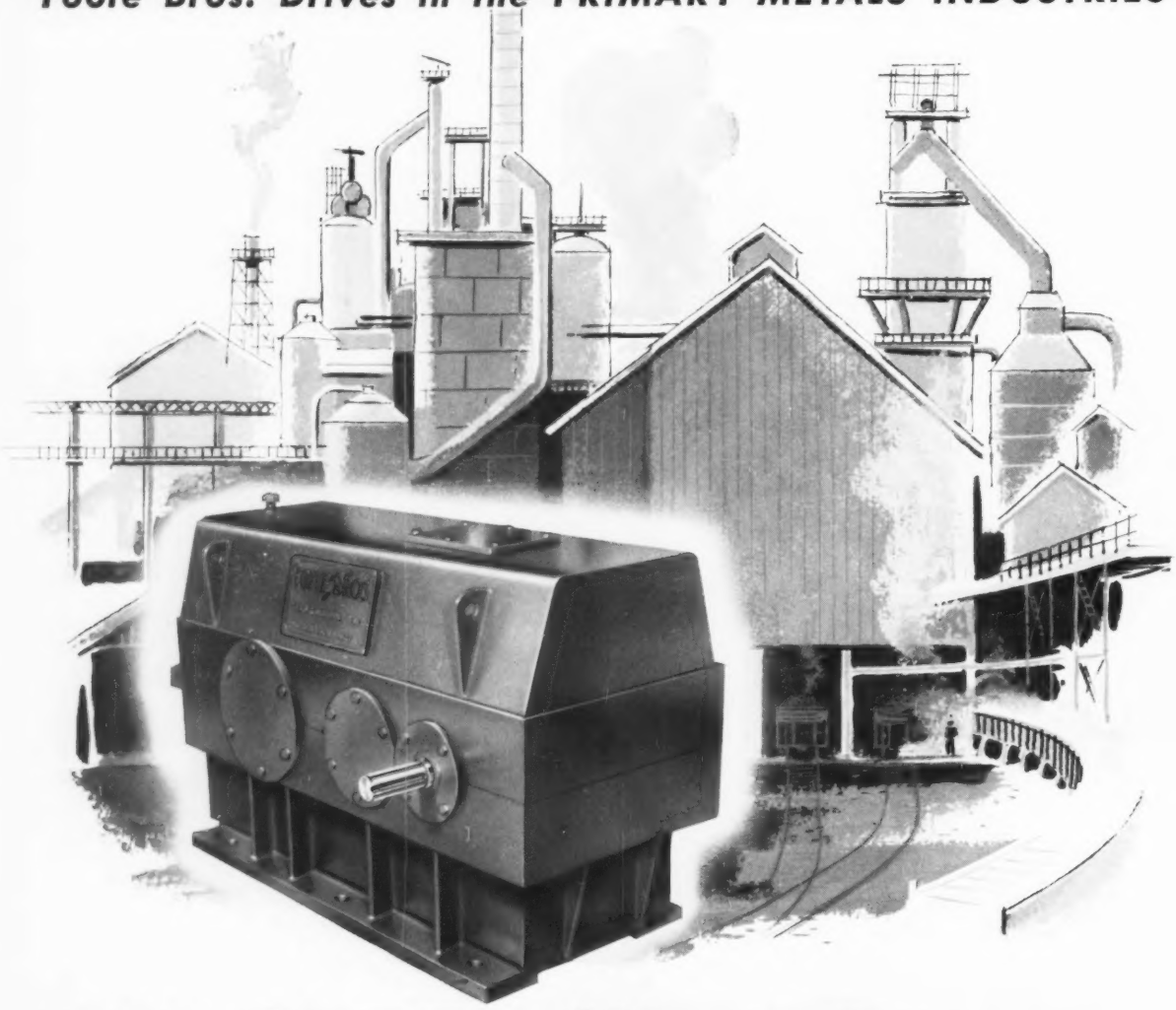
Foote Bros. Drives in the PRIMARY METALS INDUSTRIES



ALL STEEL Maxi-Power...

maximum performance drive in a tough steel housing

Add a functionally designed and carefully engineered, high strength fabricated steel housing to the basic heavy duty Maxi-Power Parallel Shaft Helical Gear Drive components, and you get a unit that is capable of resisting severe external impact, in addition to delivering maximum performance.

Maxi-Power Drives are found in the Primary Metals Industries wherever power demands are heavy, and operating conditions require the ultimate in strength, stamina and efficiency.

The heavy, precision machined steel bed of these drives keeps broad faced helical gearing in precise alignment to provide a smooth, overlapping mesh with close backlash tolerances. Tooth deflection is uniform under the heaviest loads. Heavy duty anti-friction bearings are conservatively rated to handle severest shock loads.

Maxi-Power Drives are available in nine combinations of shaft assemblies to permit a variety of gear drive arrangements between the prime mover and driven equipment. Maxi-Power Drives are available in Single, Double, and Triple Reductions. Standard Ratios are from 2.08 to 1 and up to 360 to 1. Capacities to 1550 HP.

Why not get the complete story on Maxi-Power soon? Write for Engineering Manual MPB and full details on the All Steel Drive today.

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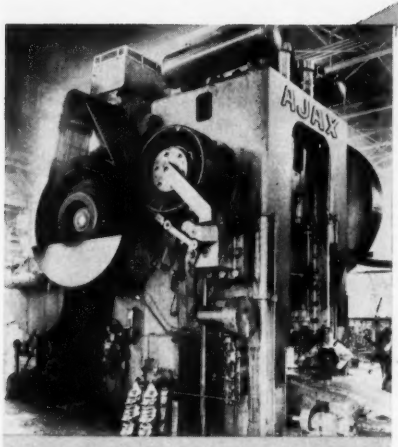
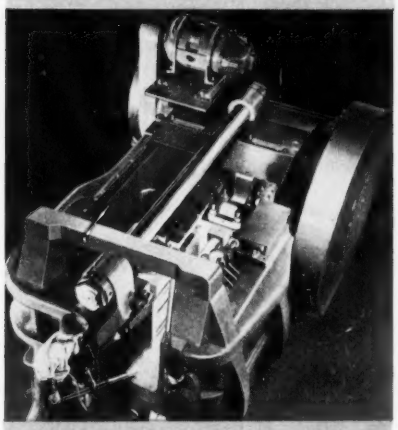
FORGING MACHINERY

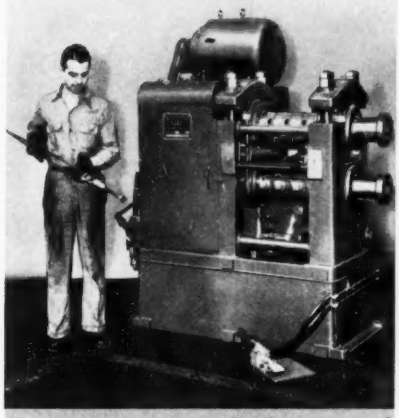
Engineered to forge more accurate parts with less machining



AJAX "HIGH SPEED" FORGING PRESSES



AJAX "AIR CLUTCH" FORGING MACHINES



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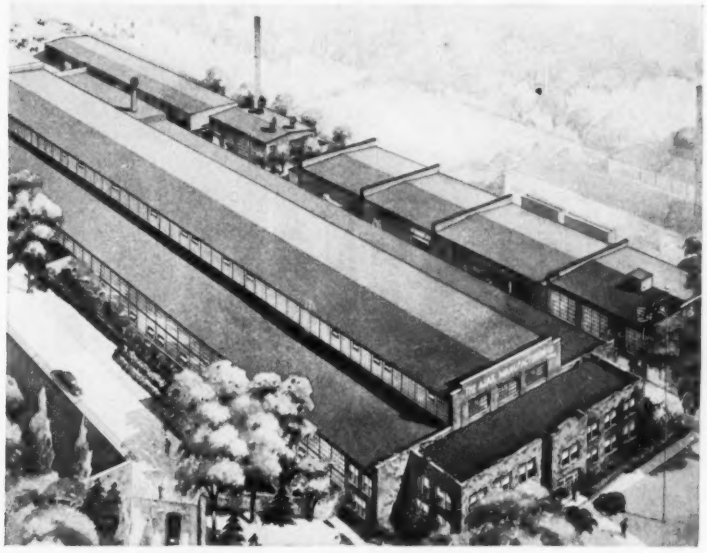
AJAX MACHINES are built with exceptionally rigid bed frames to assure excellent alignment and accurate die match.

SOLID STEEL FRAMES provide the maximum rigidity necessary for the production of uniform and accurate forged parts.

For a greater saving in material and machining costs . . . Specify AJAX Forging Machinery.



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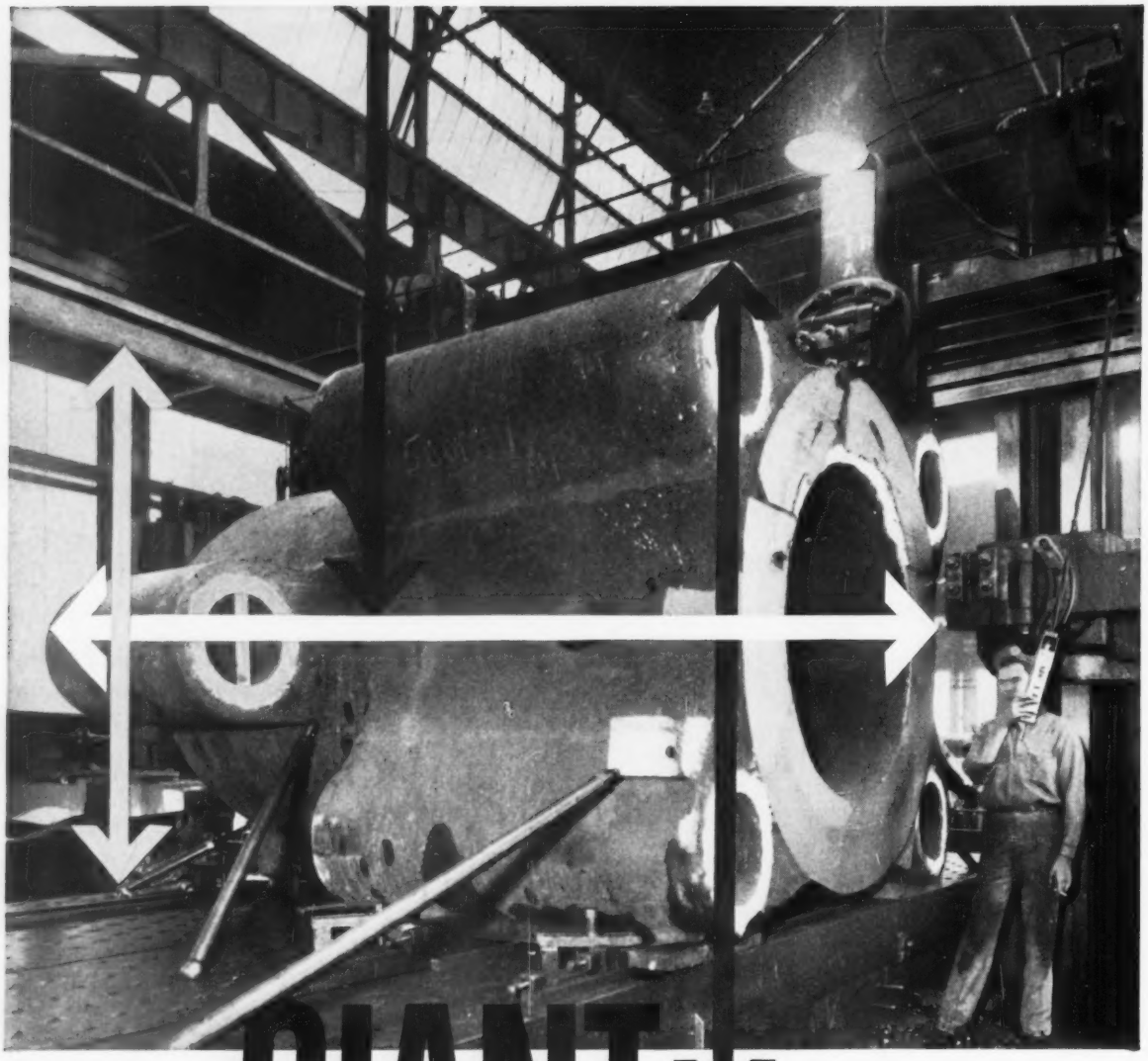

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IN THE MAKING

Machining a giant press cylinder... The machining of this huge casting or the building of a complete machine, large or small, is the type of machine work regularly performed in SUN SHIP machinery plant where marine and industrial machinery is built.

We solicit jobbing machine work. Inquiries to our Sales Engineering Department will receive prompt attention.

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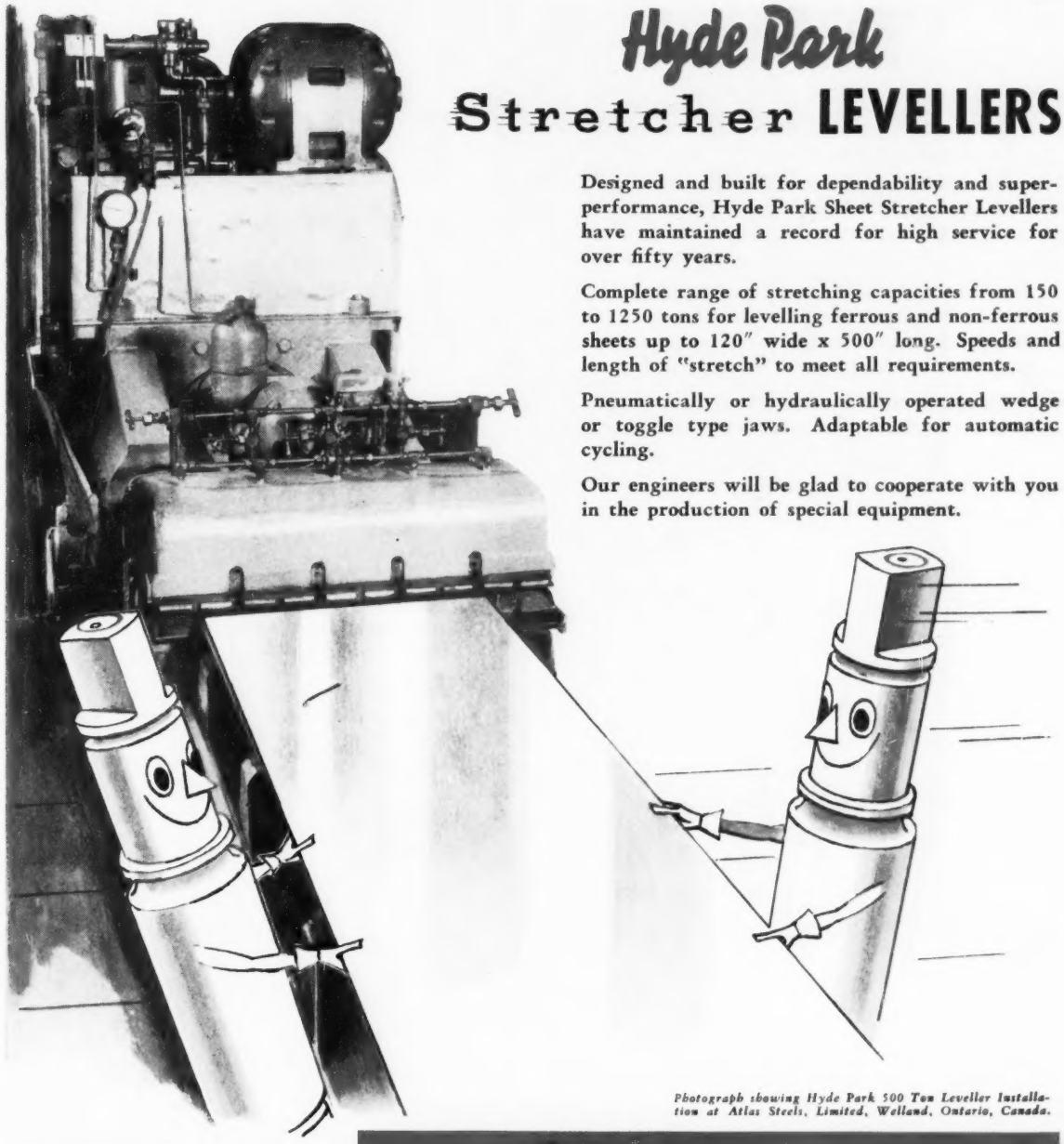
Hyde Park Stretcher LEVELLERS

Designed and built for dependability and super-performance, Hyde Park Sheet Stretcher Levellers have maintained a record for high service for over fifty years.

Complete range of stretching capacities from 150 to 1250 tons for levelling ferrous and non-ferrous sheets up to 120″ wide x 500″ long. Speeds and length of "stretch" to meet all requirements.

Pneumatically or hydraulically operated wedge or toggle type jaws. Adaptable for automatic cycling.

Our engineers will be glad to cooperate with you in the production of special equipment.



Photograph showing Hyde Park 500 Ton Leveller Installation at Atlas Steels, Limited, Welland, Ontario, Canada.

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Grain Rolls	Moly Rolls
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All Grades Nickel Alloy Iron Rolls for Hot and Cold Rolling

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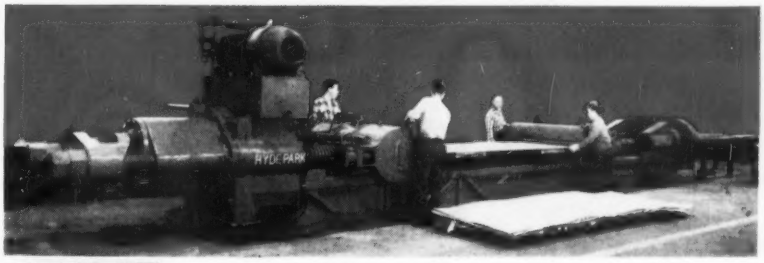
Heavy Die Castings	Slag Pots
Bases	Heavy Tool Castings
Housings	Floor Plates



Hyde Park

RED CIRCLE Rolls ALLOY-CHILLED

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"Fish & Hook" Hand Saws, Bow Saws and Saw Tools . . . Files, Chisels, Gouges, Pliers and Scythes

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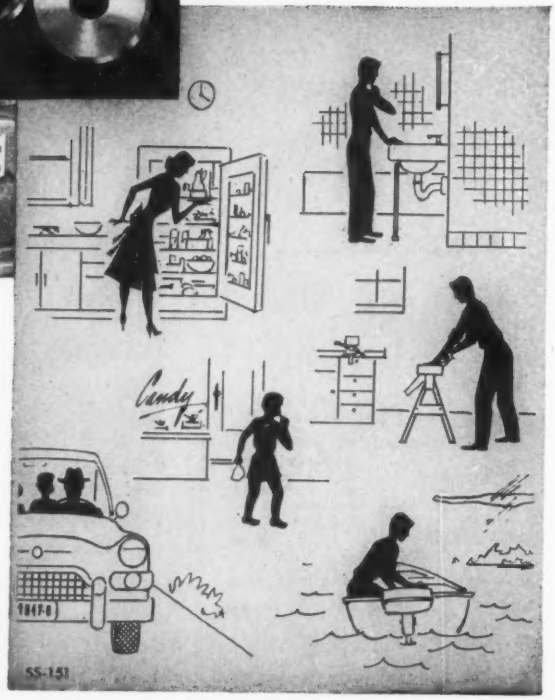
Serve Millions Of Americans

In razor blades and refrigerators, in clocks and cars, in hand saws and industrial tools, in chemicals and candy . . . almost anywhere you look, Americans use Sandvik products.

From coast to coast, Sandvik's consistent product quality and specialized service benefit both industry and the individual consumer. That's the reason why Sandvik has been growing with America since 1878.



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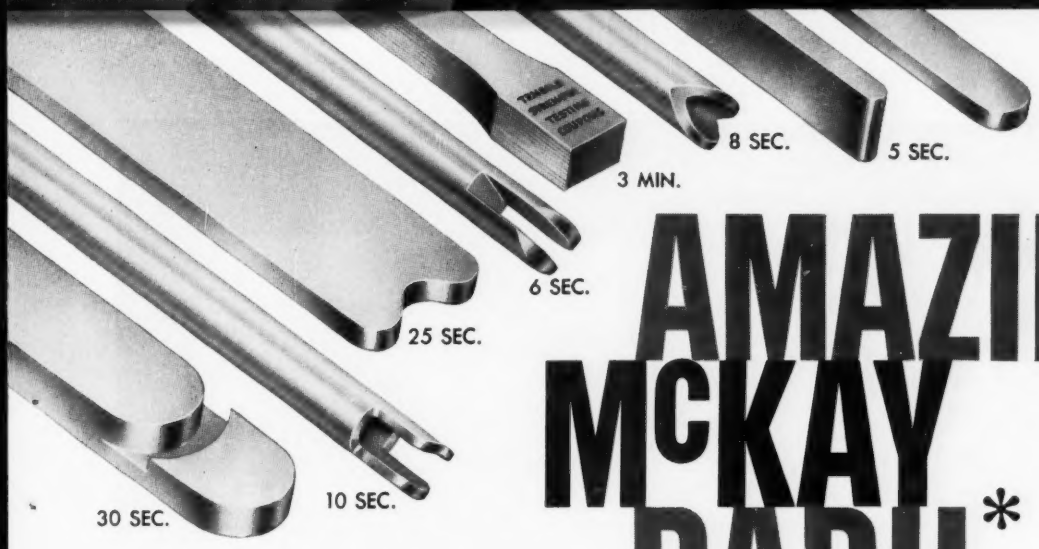

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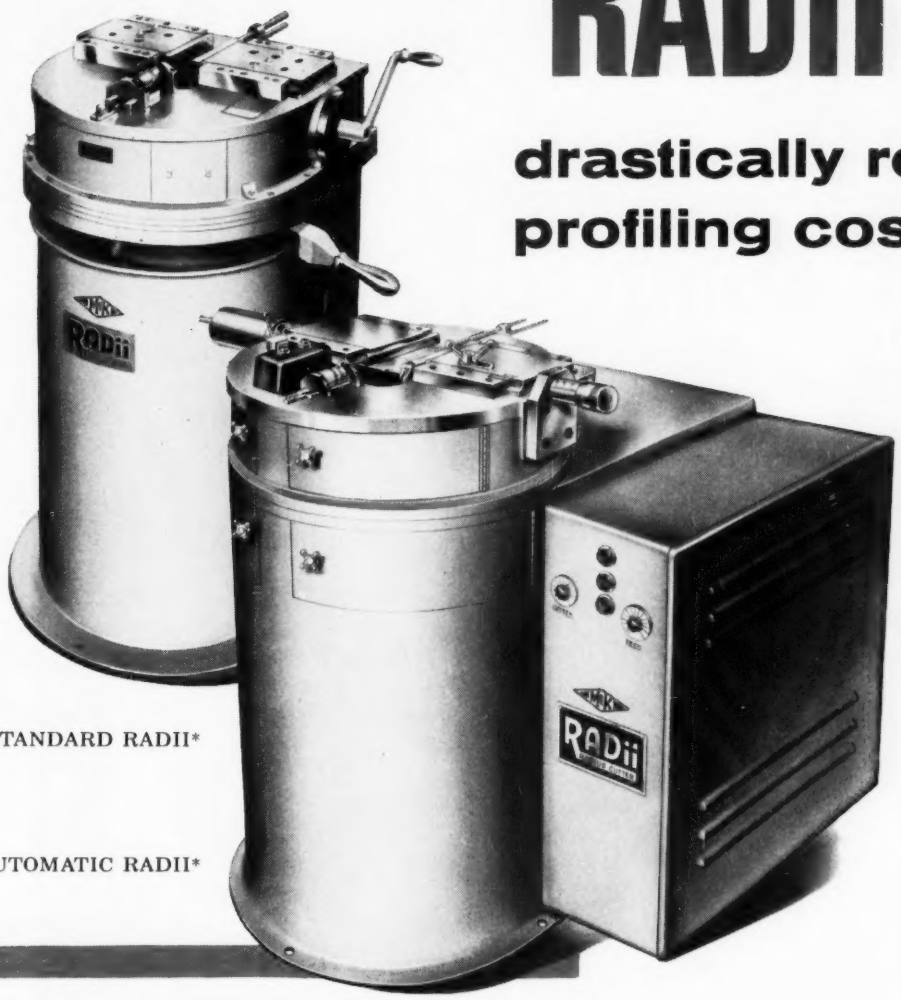
drastically reduces profiling costs!



STANDARD RADII*

AUTOMATIC RADII*

Precision profile milling can now be accomplished in seconds with unskilled labor.

The amazing new McKay Radii will cut either simple radii or irregular shapes with no set-up or layout. The operator simply slips the material to be profiled into a simple vise and moves a handle through a 180 degree arc.

Available in either manual or pushbutton automatic models the Radii is modestly priced and requires less than 10 square feet of floor space and only standard shop electrical and air facilities.

For literature or further information on this outstanding cost-cutter write *McKay Machine Company, Youngstown 1, Ohio.*

*Radii is a trademark of the McKay Machine Co.

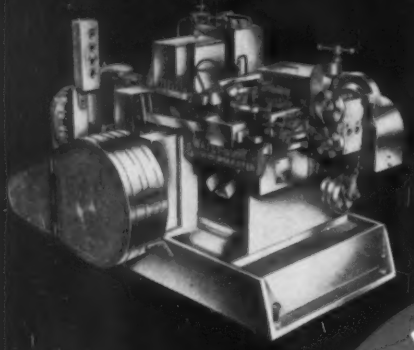
SEE IT AT THE METAL SHOW

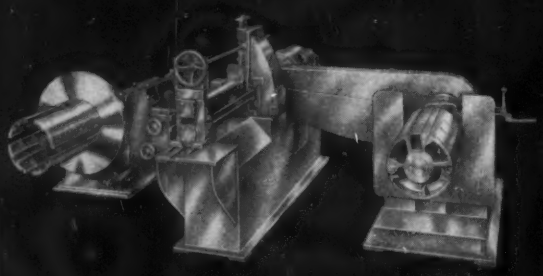
Both the semi-automatic and automatic models of the McKay Radii will be in full operation at the Metal Show in Chicago, Nov. 2-6. Make a note now to see this revolutionary new machine in action.

BOOTH 1843 EXHIBITION HALL

McKAY MCK MACHINE

COLD HEADING MACHINERY



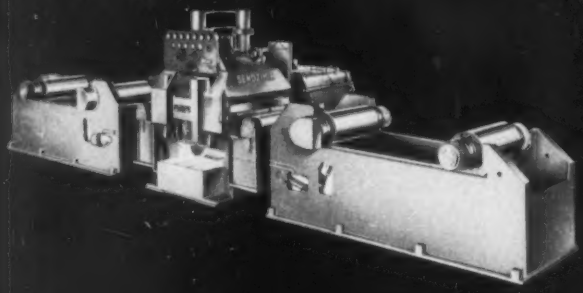


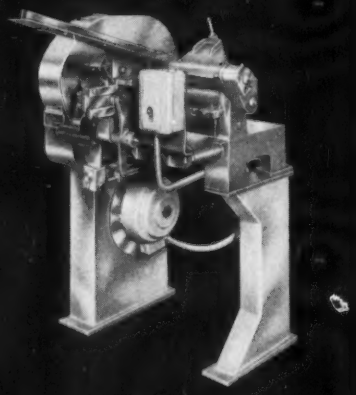
EYELET, SLITTER & WIRE MACHINERY

WATERBURY FARREL

MACHINERY BUILDERS

ROLLING MILL MACHINERY





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WF 64

A 3M Case History Report

DEBURRING-POLISHING TIME CUT 40% WITH "PG" WHEELS

MANUFACTURER: LeTourneau-Westinghouse Company

ADDRESS: Peoria, Illinois

PRODUCT MANUFACTURED: Earth Moving Equipment

3M ABRASIVE USED: "PG" Wheels

HOW 3M ABRASIVES ARE USED: "PG" Wheels used for contour polishing of air brake backing plate. Malleable cast-iron plate requires super-smooth finish on two concentric rings, to provide air-tight seal against neoprene air diaphragm.

OPERATIONAL DATA ON 3M METHOD: Two 1" x 10" "PG" Wheels, Grit #150 Three-M-ite Resinbond Cloth, mounted side-by-side on shop-made polishing shaft uniformly deburr and polish plate ring surfaces in 2-3 minutes.

OPERATIONAL DATA ON PREVIOUS METHOD: Overall deburring and polishing was by hand-rubbing with emery cloth. Time required was 4-6 minutes per plate.

PROVEN ADVANTAGES OF 3M METHOD: "PG" Wheel method, as opposed to hand finishing, allows more uniform finishing as abrading pressure can be more constantly applied with machine. Average time saving of 40% realized.

WANT MORE INFORMATION? Send for free manual, "Modern metal finishing with 3M 'PG' Wheels." Write to 3M Co., St. Paul 6, Minn., Dept. ABH-109.

"PG" Wheels are manufactured in U.S.A by 3M Company, St. Paul 6, Minn. Export: 99 Park Avenue, New York. Canada: London, Ontario

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3M Coated Abrasives

"PG" WHEELS

MINNESOTA MINING AND MANUFACTURING COMPANY

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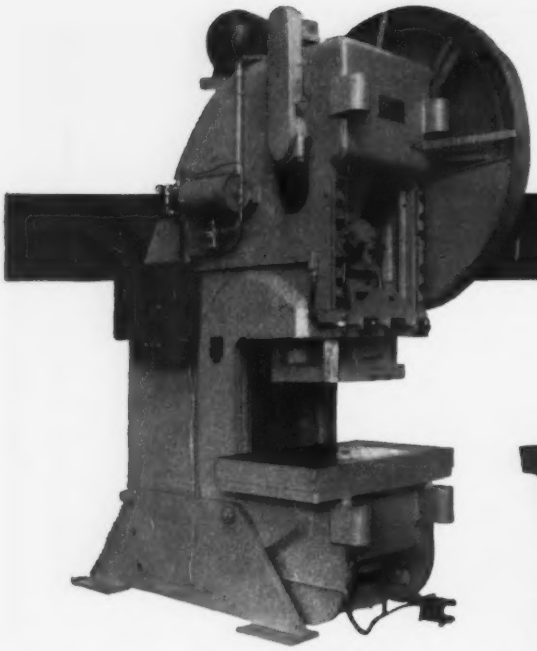
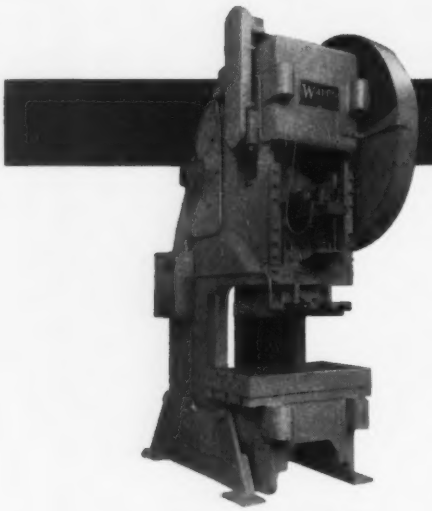
3M COMPANY



200-ton standard

Warco®

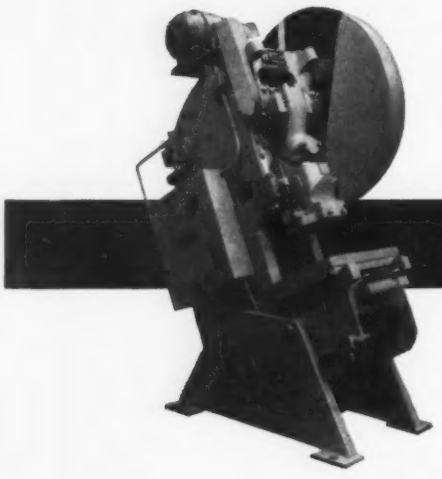


150-ton with power slide adjustment

the OBI line with the built-in extras...

Warco—Quality Press Line—gives you *all* these "extras" in an OBI press: welded steel frame of plate much stiffer than cast iron or Meehanite; pneumatically operated combined friction clutch and spring-loaded brake; saddle type connection; long, hand scraped gib ways; heat treated crankshaft; high grade steel gears with heat treated pinions; and rotary type limit switches for press control.

Before you buy any OBI, compare and you'll buy Warco. They're available in capacities from 40 to 200 ton.



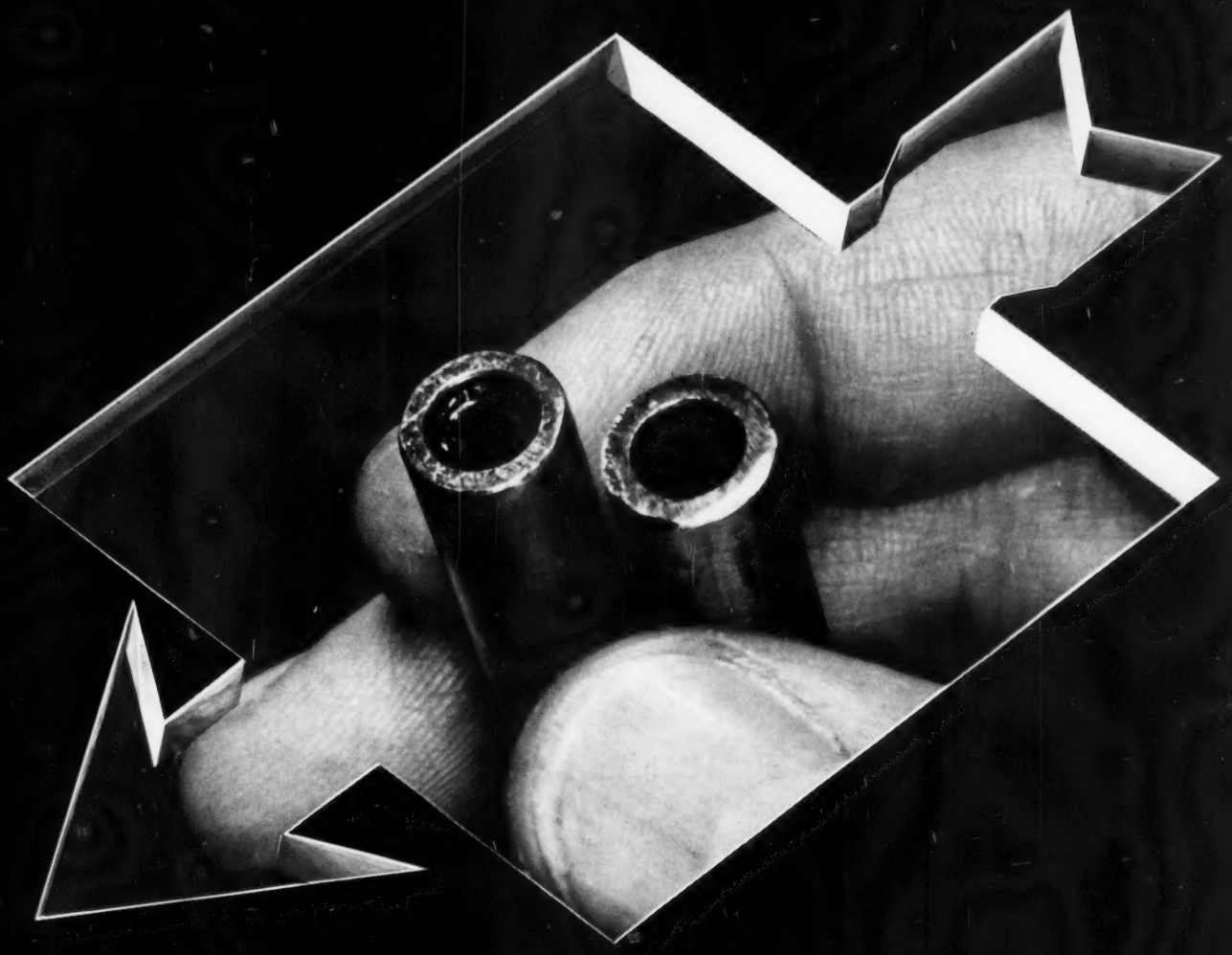
60-ton standard OBI inclined position

The Federal Machine and Welder Company
Warren • Ohio

Federal® WELDERS

Warco PRESSES®

Quality–the best economy of all



Two oils...two lines...one clogged...one cleaned

A Sunvis 700 oil and a regular oil were run through two equally clogged hydraulic lines. The regular oil couldn't remove the sludge. The Sunvis 700 oil cleaned its line thoroughly. That's one job it's made for . . . to clean out sludge deposits in hydraulic lines while it transmits power.

With a Sunvis 700 oil—like every Sunoco oil—you enjoy the best economy of all: the economy of quality. A Sunvis 700 oil lasts longer. The machinery it protects lasts longer. It prevents rust . . . ups output by reducing downtime.

FREE Trouble-Shooting Chart will help you spot and cure common hydraulic system troubles. For your copy, write to:

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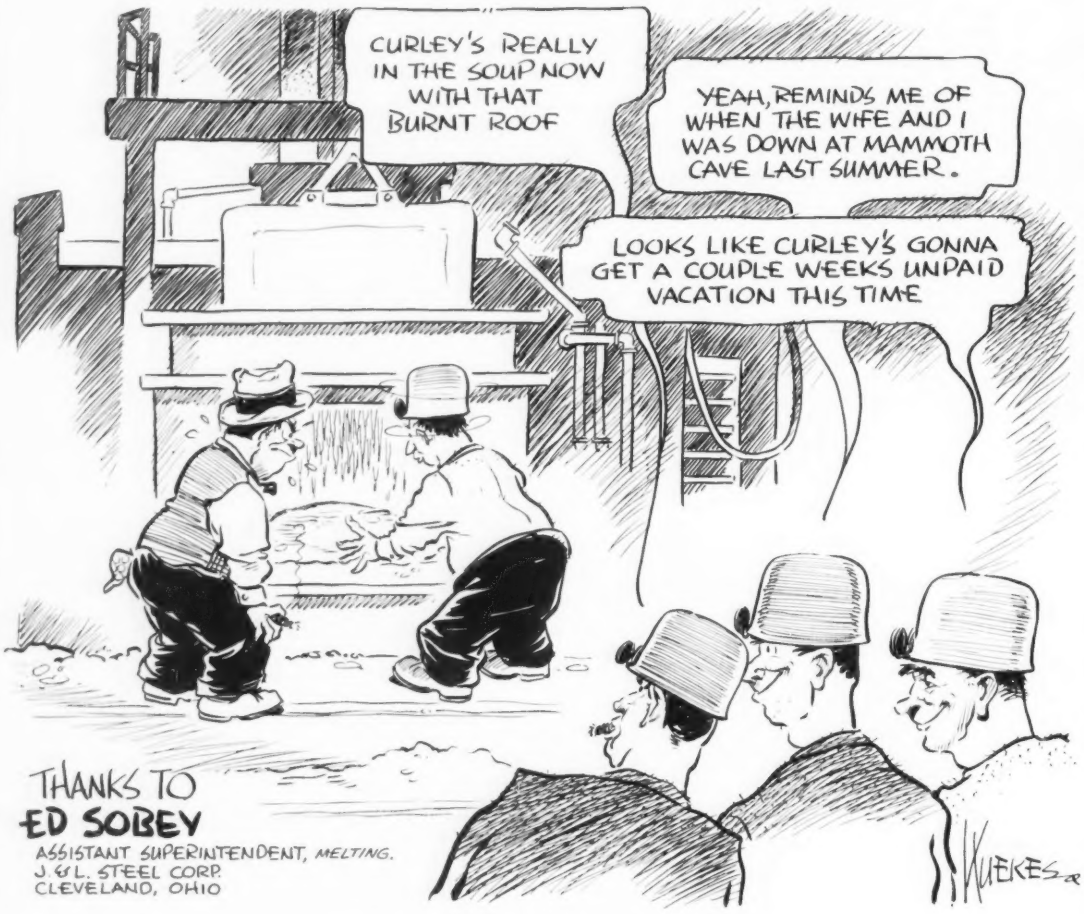
CURLEY'S REALLY IN THE SOUP NOW WITH THAT BURNT ROOF
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ASSISTANT SUPERINTENDENT, MELTING.
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The Stalactites

WHY NOT DESCRIBE YOUR OPEN-HEARTH CARTOON IDEA AND SEND IT ALONG TO US?

The benefits steelmakers obtain from our refractories are in part a result of Basic's on-the-job servicing. One of the rewards of this close relationship has been the opportunity to observe and appreciate the lighter side of these usually serious craftsmen.

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BASIC INCORPORATED 845 HANNA BUILDING • CLEVELAND 15, OHIO

October 26, 1959

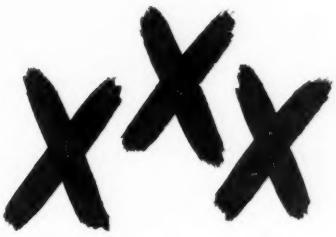
Next Step in Steel Battle: A Fight for Men's Minds

All those legal sounds you're hearing from the United Steelworkers in federal courts have one aim: Convince the little guy on the right to strike when the 80 day injunction ends. The union doesn't expect to quash the injunction; but it's shooting for a public relations success. The federal courts provide a good forum. Until the election is held (60 days after the injunction), look for a heated contest between union and management. It'll be a battle for men's minds (Page 91).

Six States Extend 'Pay for No Work' Periods

Six states have enacted permanent laws which automatically extend benefits to idle workers when unemployment reaches specified levels—6 per cent of the UC-covered labor force in California, Idaho, and Connecticut, 7 per cent in Vermont, 9 per cent in North Carolina, 4.375 per cent in Illinois. The normal maximum period during which benefits may be paid is 26 weeks in all six states. But an additional 13 weeks are permitted under the new laws in five states, eight weeks in North Carolina, reports Commerce Clearing House, Chicago. CCH looks for other states to consider such legislation.

Manpower: The Shortage of the '60s



These three Xs mark spots that will be tough to cover in the coming decade—managerial, technical, and skilled jobs. In the coming decade, our consuming population will grow much faster than our producing population. We'll have only slight growth in the age groups most important to industry. Result: A manpower shortage more severe than in any other peacetime era (Page 96).

Steel Strike Flattens Handling Equipment Orders

"Many firms are holding back on order placement for material handling equipment," reports Eugene Caldwell, president, Material Handling Institute. "Budget appropriations exist, and the desire to purchase is present, but buyers are fearful of added expenditures at this point in the steel strike," he

adds. MHI's index of order volume in August dropped to 87 per cent of the 1954 average—the lowest level since September, 1958, and the second lowest point since 1953.

Strike Affects Freight Car Orders Too

September orders for new freight cars dropped to 945 from 1753 in August, reports American Railway Car Institute. In September, 2481 cars were delivered to railroads vs. 4890 in August. Order backlogs remain high: The Oct. 1 level of 35,626 compares with 24,982 a year earlier.

NASA Charts New Material Horizons

The National Aeronautics & Space Administration is studying materials to solve the re-entry problem. The results of its Mercury project tests will have important implications for metalworking. The best answer to re-entry so far is ablative materials, so called because they're sacrificed to carry away heat. Among materials studied: Laminated phenolic glass (Page 106).

Take Inventory if Steel Shortage Forces Shutdown

S. A. Girard, president, Willys Motors Inc., says his firm has enough steel to last till about Nov. 9. The firm may schedule its annual inventory shutdown on that date if it is forced to close operations because of a steel shortage. That may be an idea for you.

Aluminum Joins Housing in Promotion

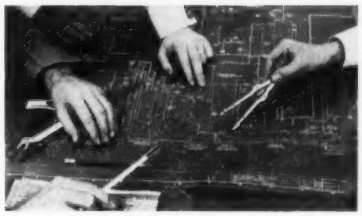
Not only did the aluminum industry team up with National Homes Corp. to develop an aluminum home; it's now joining in the biggest sales campaign in the home-building industry's history. This could be the light metal's sharpest wedge in its largest potential market (Page 94).

Labor Under Secretary Urges Union-Management Co-operation

Asserts Under Secretary of Labor James T. O'Connell: "There must be development, strengthening, and extension of the . . . ethical base against which to measure the prerogatives of management and the demands of labor. It is no longer a question of mere self-interest on either side but one of responsible co-operation. Management has an obligation to conduct its business in the public interest and to yield to labor's demands when they are justified. Labor

has an obligation to preserve its identity as a public trust and an instrument for social progress . . . and an obligation to temper its demands in the light of the national welfare."

Three-Company Combine to Push Strategic-Udy Process



Koppers Co. Inc., Pittsburgh, and Strategic Materials Corp., Buffalo and Niagara Falls, Ont., have joined hands with Elektrokemisk A/S, Oslo, Norway, builder of electric furnaces, to exploit the world market for Strategic-Udy ore smelting plants (Page 233).

Justice Department Still Needles GM

The Department of Justice is seeking to require General Motors Corp. to dispose of its Euclid Div., builder of earth moving equipment. Says GM's chairman, Frederic G. Donner: "It is difficult to understand the position of the attorney general." GM acquired Euclid six years ago, after an investigation by the Justice Department. The division accounts for about 5 per cent of the earth moving equipment industry volume.

Are 1 Million psi Steels Possible?

"Yes," predict experts. Watch the work being done on superalloys and refractory metals. Vanadium-Alloys Steel Co. claims to have a 650,000 psi tool steel, but the material has limited ductility. Ford Motor Co.'s success with 500,000 psi alloys in its lab shows that better ductility is possible. Progress seems to hinge on two things: Refinement techniques like pressure melting and new combinations of alloying elements (International Nickel Co.'s research is in this area), Page 141.

Peaceful Atom to Be Competitive by 1970

Competitive atomic powerplants will become a reality within the next ten years, believes General Electric Co. The firm thinks the boiling water reactor holds the most promise. Says GE: By 1970, atomic plants will be competitive with 25 per cent of the fossil-fuel plants then being installed.

GNP: Up Nicely in '60

Gross National Product probably will run at a $515 billion to $520 billion clip next year vs. the '59 third quarter rate of $490 billion, predicts Thomas Gies, former FRB economist, now a University of Michigan professor, who

says three factors will push GNP upward: 1. Increased capital spending, particularly for equipment. 2. Rising consumer demand. 3. Higher government spending. Professor Gies adds that inventory accumulation by business probably will increase at a $3 billion to $4 billion rate next year—somewhat slower than it did in the forepart of this year.

Business Picks Up in Canada

Canadian business reflects new peaks of activity, reports the Canadian Association of Purchasing Agents. In September, new orders were above the August level at 50 per cent of the companies surveyed; only 30 per cent had higher orders in August than in July. Employment is down slightly, due to the laying off of summer help. Prices are holding steady.

Housing Starts Drop, but Stay High

Private, nonfarm housing starts in September totaled 117,000—6 per cent less than the August figure. But the seasonally adjusted annual rate for the first nine months of this year averaged 1,375,000—up 310,000 from last year, reports the Commerce Department.

St. Lawrence Seaway Closing Dates Set

Ships using the St. Lawrence Seaway have little more than a month left for transit before winter weather closes the canals. The Coast Guard has set these closing dates: Nov. 30 for the South Shore (Montreal to Lake St. Louis), Beauharnois, Iroquois, Lachine, and Cornwall Canals; Dec. 15 for the Welland Canal; Dec. 12 for the Sault Ste. Marie Canal.

How Big Are New Oxygen Steelmaking Facilities?

Expansion plans incorporating the use of oxygen have been announced by Jones & Laughlin, Weirton, and Granite City. An idea of the magnitude of the ventures comes from Air Products Inc. Says that firm: The oxygen required for the plants will amount to about 50 per cent of all the oxygen consumed by the U. S. steel industry in 1958.

Straws in the Wind

Steel output next year will climb to a record of 120 million to 130 million ingot tons, predicts Charles M. White, chairman, Republic Steel Corp. . . . American Steel Foundries' Griffin Wheel subsidiary and U. S. Steel Corp. are working on a "pressure pouring" development that promises to be the biggest step toward continuous casting so far . . . American Iron & Steel Institute has set up a Committee to Promote the Use of Iron & Steel Products . . . Farm machinery makers expect 1959 sales to top 1958's by about 15 per cent . . . Midland-Ross Corp. is negotiating for the acquisition of Surface Combustion Corp. . . . Auto sales in '60 may exceed 7 million units, predicts George P. Hitchings, manager, economic analysis department, Ford Motor Co. . . . Alan Wood Steel Co. plans to build a new combination blooming mill and plate mill costing more than $25 million.

Slammin' Sam Snead fails to flake Inland TI-CO®

As one of golf's great players, Slammin' Sam earned his name and fame with a driving power that has seldom been equalled. His swing is deceptively easy —yet it drives the ball with astounding force and speed. At Boca Raton, Sam drove ball after ball into an Inland TI-CO galvanized sheet. Each impact was terrific. One would expect such punishment to be devastating, yet, though the TI-CO sheet was battered and dented—*there was no flaking of the zinc coating whatsoever!*

All year 'round in product fabrication and assembly; in a limitless variety of commercial and residential applications; Inland TI-CO regularly takes equally tough treatment—deep-drawing, spin-drawing, Pittsburgh lock-seaming, crimping, punching, hammering—*without cracking, peeling or flaking!*

Sam couldn't believe it either 'til he examined the TI-CO sheet for himself. *Not a trace of flaking!*

Consult your Inland Representative regarding *your* galvanized sheet or coil requirements. And send for your free TI-CO booklet containing technical data and complete information. TI-CO is produced with dry, oiled or chemically treated surfaces in sheet and coil form in a wide variety of gages and widths.

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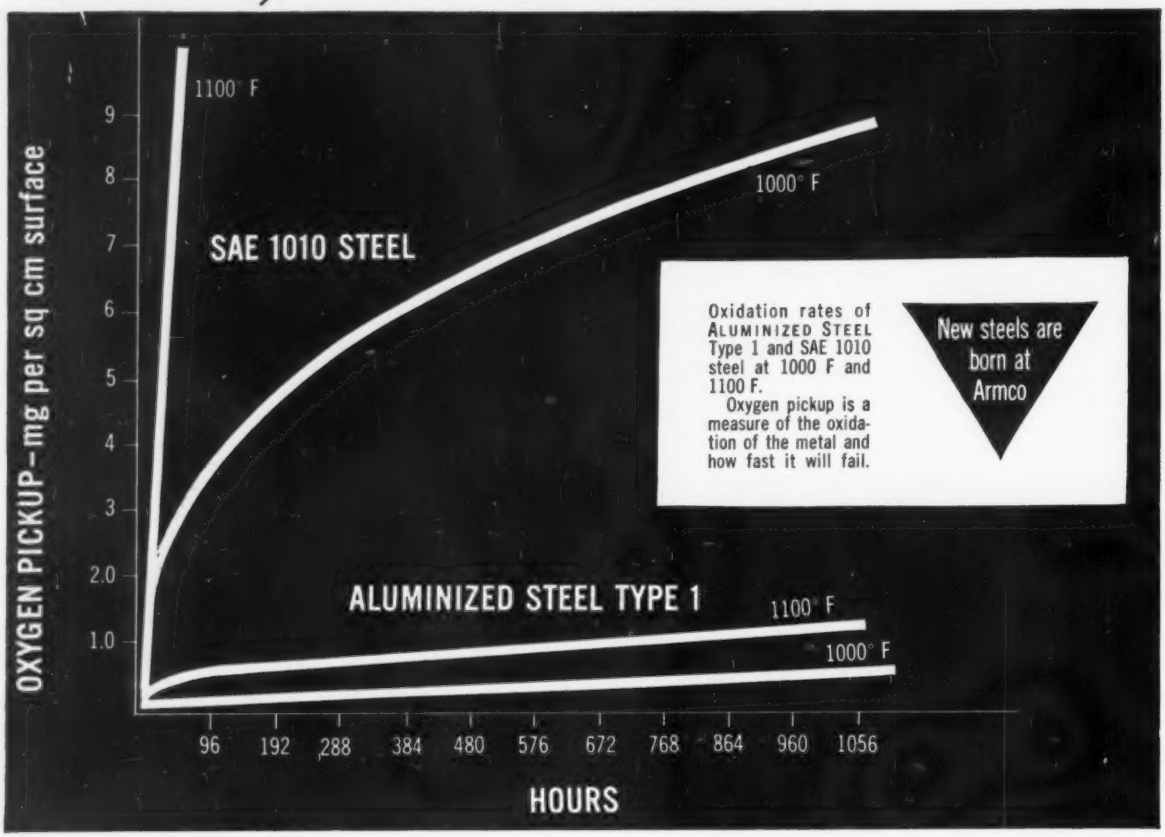


Research Data Shows Why Armco's Special Aluminum-Coated Steel Withstands Heat

Comparative oxidation rates indicate remarkable durability of corrosion-resistant Armco ALUMINIZED STEEL Type 1 at high temperatures.

Oxidation rates of ALUMINIZED STEEL Type 1 at 1000 and 1100 F compared with those of SAE 1010 steel demonstrate why this special Armco Steel has become a popular material for parts that must resist heat.

The hot-dip aluminum coating applied by a special Armco-developed process prevents oxygen from destructively scaling the base metal at temperatures up to about 1250 F. In addition, ALUMINIZED STEEL also provides good corrosion resistance. This unique combination of steel and aluminum withstands the corrosive attack of combustion products and condensates.

Because ALUMINIZED STEEL Type 1 combats both heat and corrosion and because its steel base gives parts high strength, it can be used in thinner gages and at higher temperatures than other metals.

For these reasons, Armco's special aluminum-coated steel has proved to be the most economical and durable metal for auto mufflers, heat exchangers, combustion chambers, industrial ovens, appliances, and similar products requiring resistance to heat and corrosion. Put the cost-cutting, performance-improving advantages of Armco ALUMINIZED STEEL Type 1 to work in your products. Write us for complete information. Armco Steel Corporation, 3249 Curtis Street, Middletown, Ohio.

ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation

After 80 Days, What?

Invoking the Taft-Hartley Act to force steelworkers back to their jobs solves no basic labor problems in the steel industry.

It only leads to the question: "After the 80 day cooling off period, what happens?"

The national emergency provisions of the act are mild and ineffective.

The fact finding board headed by George W. Taylor, a labor relations professor at the University of Pennsylvania, could only report to the President on the status of the negotiations.

It could make no recommendations.

In opposing the injunction sought by the government in federal court at Pittsburgh, USW Counsel Arthur J. Goldberg could legitimately argue that the strike had not endangered national health and safety per se.

He could completely overlook the stark fact that the shutdown is endangering the welfare of the entire economy because steel is the foundation for 40 per cent of the nation's industry.

After 60 days (unless by some miracle the industry and the union grind out an agreement), the National Labor Relations Board can ask the steelworkers to vote "yes" or "no" on the industry's last offer.

The results of the poll, taken company by company, no doubt will influence USW President Dave McDonald's thinking, but they are not binding.

After 80 days, if he does not get his way, McDonald says his members "will fight on with more determination than ever."

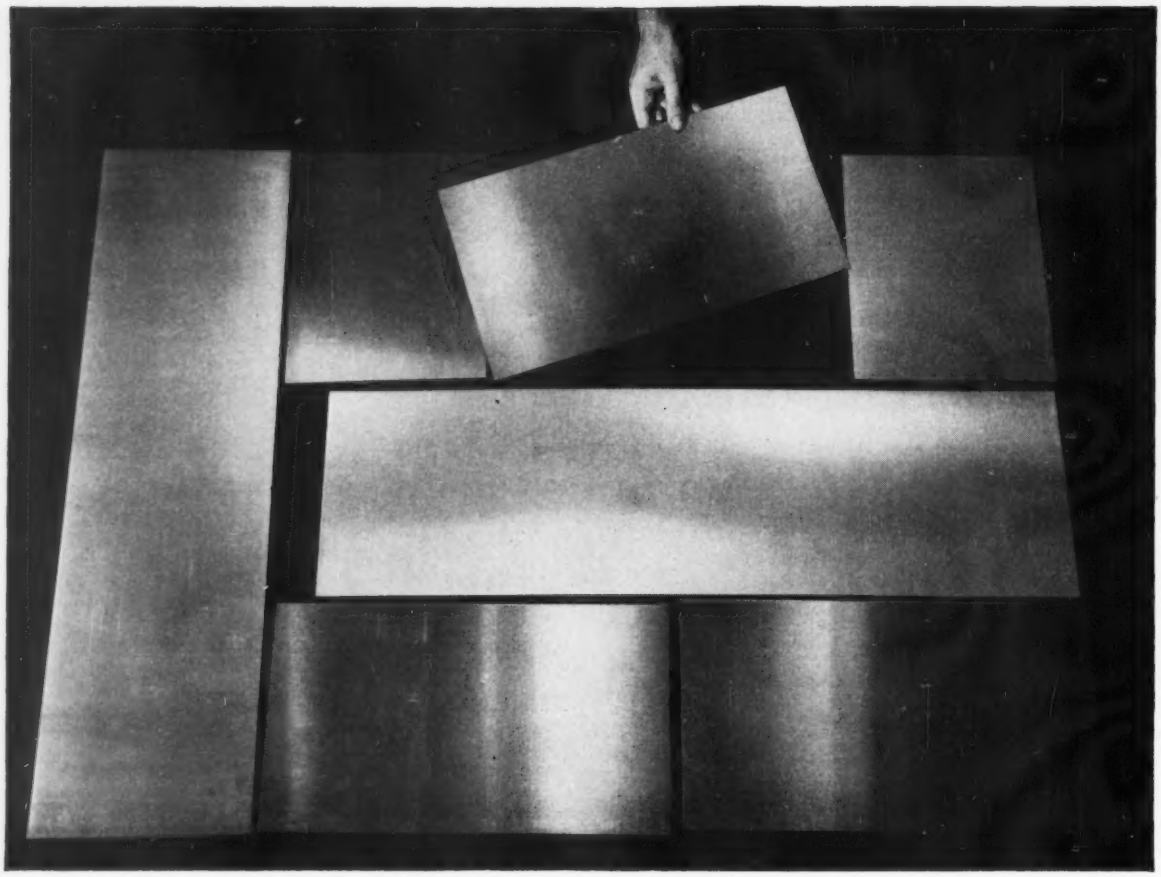
There will be nothing to stop him.

The fault, of course, lies with our legislative processes. They have not kept pace with the swift rise to power of the unions and the changing role of workers in an era of rapid technological progress.

Why, after 80 days, should one man be endowed with enough power to throttle our nation's economy until industry complies with his demands?

Irwin H. Such

EDITOR-IN-CHIEF



How many sheets could you make from today's waste aluminum?

If you tend to shrug off scrap as an unavoidable business loss, here's a plan that can change your thinking. It's the Ryerson Aluminum Sheet Plan that makes exact lengths and widths available to most users—generally on a *net weight basis.*

Under this plan, you order the exact sizes you need for your production runs—and Ryerson produces them quickly from coil stock on the most modern and accurate slitters and cut-to-length lines. You thus avoid buying metal that you cannot use . . . save the time and labor of processing within your own plant. And in addition, Ryerson can schedule deliveries to match your production pace, enabling you to convert storage space to more productive use and release capital tied up in inventories.

Here you'll find the widest selection of alloys, tempers and thicknesses plus expert technical help on selection and fabrication problems. So ask your Ryerson representative to review your production requirements with you and show you how to eliminate your scrap problems immediately.

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Joseph T. Ryerson & Son, Inc., Member of the INLAND® Steel Family

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Next in Steel: Battle for Minds

THE LEGAL skirmishing over the Taft-Hartley injunction to bring steel strikers back on the job has just one cause: The steel union is using the federal courts as its major forum in a bid to win the battle for men's minds.

Even the union does not expect a legal victory, but it hopes for a public relations success. Object: To persuade its members to vote to continue the strike. T-H provides that an election among union members must be held after 60 days of injunction to determine if they will accept management's last offer (see the accompanying exhibit for an analysis of the T-H voting feature).

• **Union Forum**—Besides the federal courts, the union will, according to President David J. McDonald, "fight with might and main" on every front to persuade the members and the public that its cause is just and that the government is unjust in forcing strikers back to work.

USW's general counsel, Arthur Goldberg, will argue that the steel strike doesn't constitute a national emergency, that the 13 per cent of the industry not struck can take care of the nation's defense needs. He will also contend that T-H's injunction feature is unconstitutional.

• **Management Forum**—Look for steel management to direct its appeal to workers' families. Via news-

Function of T-H Voting Disputed

AN UNUSUAL election that could turn labor relations history probably will be held in late December. Unless the steel companies and the union settle during the first 60 days of the Taft-Hartley injunction, the National Labor Relations Board will be conducting a secret ballot for 15 days at yearend. Union members will be asked: Do you accept the companies' last offer?

Although the feature of voting on the last offer has been used before during T-H injunctions, the results have never been conclusive, and the mechanism has never had a true test. Past votes have been boycotted by union members, or a back-to-work movement had already started during the election that obscured the results. Consequently, some questions have never been answered. STEEL sought clarification from legal beagles in Washington (in and out of the government) on:

1. Can union leaders ignore the vote if members approve the last offer?

2. Does the national majority rule, or can employees from each plant or company determine local action?

Here's what National Labor Relations Board and Justice Department people told us:

The T-H election has no legal status. Union leaders are not bound legally to accept the will of the majority. But government experts don't think the leaders would dare ignore a clear mandate to accept the last offer because of public opinion. The national majority definitely rules. If some important pockets of the membership want to accept but the national majority votes the other way, union leaders have their power and persuasive abilities at hand to bring the dissidents into line with the majority.

But STEEL got a strong dissenting opinion from Fred A. Hartley Jr., co-author of the law and now a consultant:

He agrees that the voting mechanism has never had a real test. He agrees that the national majority rules. But he believes the NLRB and Justice interpretations about the legality of the election are wrong. "If union leaders do not act as the majority decides in the election, the federal government should hail them into court for violating the law," he says.

What Each Side Has Proposed in the Steel Case

Offer by:	Industry Oct. 1		Union Oct. 1		Union Oct. 12 & 13		Union Oct. 16		Industry Oct. 17
Period covered:	2 years		33 months		1, 2, or 3 years 3 year basis		20 months		3 years
Cost estimates by:	Union	Industry	U.	I.	U.	I.	U.	I.	I.
Total cost of wage increases, cents per hour worked	8.3	9.8	27.9	33.1	28.2	33.1	9.4	11.0	19.4
Total cost of SUB, insurance, pensions, holiday premiums, vacations & Sunday overtime, cents per hour worked	1.9	5.6	6.5	18.9	16.8	23.3	10.4	17.8	10.0
Plus cost of living (potential), cents per hour worked				10.8		10.8		3.6	3.6
Cost of total package cents per hour worked	10.2	15.4	34.4	62.8	45.0	67.2	19.8	32.4	33.0
Average annual increase as a percentage	1.4	2.0	3.3	5.8	3.9	5.7	3.1	5.0	2.9

In addition to the wage and fringe proposals made by each side (see summary above), the companies advanced this offer on Oct. 18: Submit the question of local working conditions to binding arbitration by a three man board for solution within 60 days. One of the three arbitrators would be picked by the companies, one by the union, and one selected by the arbitrators. From management's viewpoint that is a key issue on which the union refuses to budge.

The current company position includes the above proposal, the economic offers made Oct. 17, and a proposal to set up a joint Human Relations Research Committee. Its jurisdiction: To study and recommend solutions for equitable wage and benefit adjustments, employment stabilization, the job classification system, wage incentives, seniority, and medical care.

The current union position includes the economic offer of Oct. 16, plus a proposal to set up a joint committee to study automation, local work conditions, seniority, and the union shop.

paper ads, radio talks, and direct mail it will hammer away at the inflation theme and the threat of foreign competition. Management will get an assist from media and the public as greater attention is paid to the personal losses of the strikers.

On the issue of local working conditions, the companies will rebut the union argument that they are threatening job security. They will maintain that efficient operations keep prices down, save sales, and jobs.

• **T-H Procedures**—The two sides are bound by Taft-Hartley to continue bargaining during the injunction. Sixty days from the date of the injunction, the inquiry panel chairmanned by Dr. George W. Taylor reports the current bargaining position. That report is made public. Then comes the controversial election, which has a time limit of 15 days. Within five more days, the results of the election are certified to the attorney general. The three periods (60, 15, and 5

days) constitute the period commonly referred to as the 80-day injunction.

If the strike begins again after the 80 days, the President submits a report to Congress "together with such recommendations as he may see fit to make." The last step is preliminary to Congressional action to solve the national emergency. (For details on what is possible here, see Page 100.)

• **Settlement?**—A check of the bargaining positions as of Oct. 16 and 17 (see the accompanying table) shows the two sides are not excessively apart on the economic side. They're still miles apart on the "local working conditions" issue. If they can resolve that, they may be able to settle before the injunction runs out.

Certainly, Kaiser Steel Corp. is restive. It reserves the right to bargain separately with the union, if it informs the other steel companies in the wage case of its action. It came close to signing in mid-October. But as of now, it's with the other firms "100 per cent."

• **Why Kaiser?** — Kaiser Steel doesn't feel that its local working problems are as serious as those of other firms. With steel sales almost solely in the West, it also believes its marketing situation is special. Finally, Kaiser Steel is a maverick because Kaiser interests also make aluminum—meaning it must deal with the USW on two fronts.

• **The Recovery Story**—Steel mills will take about four weeks from the time of work resumption to reach 90 per cent of capacity—six weeks to reach that rate of shipments. And that's the optimum, assuming minimum facility damage and minimum worker slowdowns.

The policy of the leading producers will be to fill orders on a first come, first serve basis. Smaller companies indicate they'll be more flexible. "We'll ship first to customers who need the metal badly and who were loyal to us when we needed them," one company says. "But we won't go overboard. Shipments will be in line with past buying patterns." Says another: "Our district offices are keeping us informed about customer inventories. If a company that ordered early is in no danger of running out, we might bypass it momentarily to accommodate a user in dire straits."

• **The Hardship Case** — The big companies say they definitely will not serve hardship cases out of line because it's too tough to evaluate the degree of distress. In some instances, big company sales personnel feel that users brought some of the trouble on themselves by ignoring advice to buy early.

Big and little steel companies all emphasize they won't let the big customer trample on the rights of the smaller buyers. Case in point: One small steel firm has turned down a conversion deal offered by its largest customer because that would tie up its mill too long for other users.

• **Defense Steel**—On Oct. 16, the U. S. ruled that mills would have to give priority to defense steel orders. The order applies to mills still operating and to the others as they return to work. Defense steel is a minor item, except for specialty, structural, and tubular products, and won't cause much trouble (for details on this and other delivery scheduling matters, see Page 231).

Lifo Presents Tax Threat For Steel Distributors

Steel service centers that use the Lifo method of inventory evaluation face a heavy tax burden at yearend. Reasons: Heavier than normal sales and the inability to replenish depleted inventories because of the steel strike. To some extent, manufacturing companies using Lifo will be similarly penalized, but the service centers may be particularly hard hit since inventories are their stock in trade.

In an effort to bring out the facts, the American Steel Warehouse Association last week launched a survey aimed at determining how many distributors use Lifo and how much dollar volume is involved. Some time ago it was estimated about 30 per cent of the organization's membership use the system.

Strike Losses

(Through Oct. 23)

Lost Steelworker Wages

$1,020,000,000

Lost Sales

$3,060,000,000

Lost Production **(ingot tons)**

28,300,000

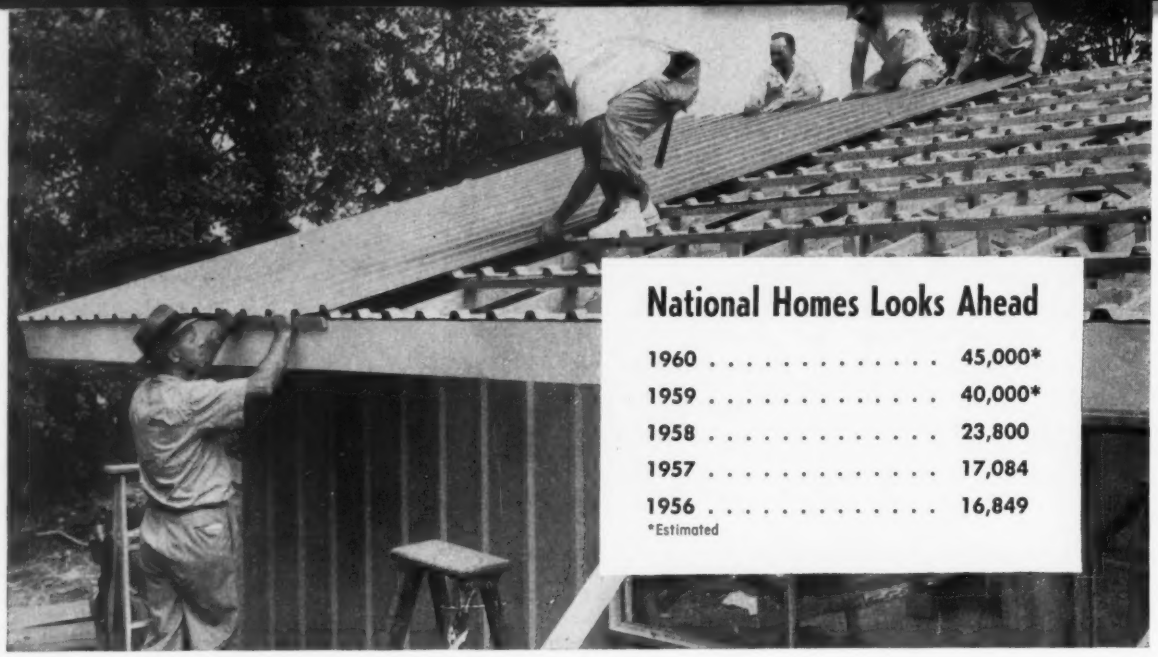
Other Losses

Overhead, depreciation, and salaries of nonproduction workers in steel.

$584,000,000

Tax Losses to U. S.

$660,000,000



National Homes Looks Ahead

1960	45,000*
1959	40,000*
1958	23,800
1957	17,084
1956	16,849

*Estimated

Aluminum Joins Prefab Home Drive

TWO DAYS after Christmas, one of the nation's favorite westerners, Maverick, will kick off the biggest advertising program in the home building industry.

The product: National Homes Corp.'s 1960 line of aluminum homes.

The giants of the fast growing, smart promoting aluminum industry—Aluminum Co. of America, Kaiser Aluminum & Chemical Corp., and Reynolds Metals Co.—are teaming up with National Homes in the campaign. To the light metal producers, it could provide their biggest wedge into the home building industry.

• An estimated 150 lb of aluminum goes into the average home today. Alcoa predicts that by 1965 the figure will be 1000. In the new National Home, the average is 1600 to 3000 lb.

The aluminum producers feel they've found their equal in promotional skill in James R. Price, chairman of National Homes. He and his firm have generated most of the force behind the postwar evolution of the prefabricated home from a boxlike structure with little public acceptance to its present reputation for quality and up-to-minute architectural features.

National Homes introduced its first aluminum home a year ago. In the first six months of this year officials reported sales of 11,799 homes, up 45 per cent from 1958's. "By midyear, nearly 70 per cent of our sales were in the aluminum models in the markets we displayed them," says Mr. Price.

In August, National Homes took another step which delighted the aluminum producers by announcing an expansion program through merger and acquisition which gave the firm 13 manufacturing plants in 12 states—New York, Pennsylvania, North Carolina, Virginia, Georgia, Tennessee, Ohio, Indiana, Illinois, Mississippi, Texas, and California.

"This network will give us manufacturing facilities within a 200-mile radius of every major housing market east of the Rocky Mountains, plus our first foothold on the West Coast," explains Mr. Price. Each of the new plants is adding facilities to produce aluminum homes.

The aluminum homes are produced on substantially the same production lines as their wood counterparts. Sidewalls, doors, and shutters have a baked-on, permanent finish of Lucite acrylic enamel developed by Du Pont. Roof, windows, and screens are of bonderized aluminum.

• The big question of many in the home building industry concerns the public's acceptance of aluminum over the conventional construction materials.

Mr. Price provides an answer for that too:

"We have run several market tests which show buyer preference for aluminum. In Chicago, our aluminum homes accounted for 95 per cent of 354 sales. In Lafayette, Ind., virtually all of 157 buyers preferred aluminum. In Pittsburgh, where the steel strike had been in progress for seven weeks, our builder-dealer reported 120 sales—all aluminum."

The aluminum industry has scored substantial gains in the home improvement market—an estimated 227,000 tons of aluminum are annually going into doors, windows, storms, siding, and awnings. If National Homes hits the sales targets it has announced, aluminum's stake

in home building will multiply.

Predicts Mr. Price: "We'll sell between 38,000 and 40,000 homes this year—45,000 in 1960. By 1975, we'll be selling 50 per cent of all housing starts in the nation."

New Blast Furnace Doubles Production

AN ULTRAHIGH pressure blast furnace with a top pressure of 40 psi, nearly four times that of any present American blast furnace, has been developed by Koppers Co. Inc., Pittsburgh. Koppers estimates that its furnace will produce two times more pig iron than furnaces of comparable size.

Example: A blast furnace with a diameter of 28 ft, now averaging about 2000 tons daily at normal pressures, will turn out 4000 tons daily at 40 psi. The new furnace costs 20 to 25 per cent more than conventional furnaces. Koppers also reports that the labor costs of producing a ton of pig iron are cut 30 to 35 per cent with its system.

• **New Design** — The concept requires a completely new installation, rather than the addition of high pressure equipment to a facility. Koppers notes that its system differs from conventional blast furnaces in these respects: 1. Furnace, hot blast stoves, and other facilities must be constructed as pressure vessels. Stoves require special anchoring. 2. The gas system is designed for assured sealing, even against minute leakage. 3. Capacity of blowing facilities is greatly expanded. 4. The conventional blast furnace charging system is not employed, and the traditional large bell is eliminated. 5. The high pressure used to clean the gas obviates the need for electrical precipitators. 6. Doubled pig iron output requires doubled casthouse facilities, including two tapholes, two mud guns, and duplicate runner systems.

Because of its high rate of production, the Koppers furnace appears especially applicable to steel plants requiring a substantial boost in pig iron capacity.

For more on Koppers, turn to Page 233.

Allis-Chalmers converts chemical energy to electricity as . . .

New Energy Source Debuts

A MIXTURE of fuel gases—largely propane—provides chemical energy which is converted into electrical energy in a fuel cell developed by Allis-Chalmers Mfg. Co., Milwaukee.

Allis-Chalmers has installed a bank of 1008 cells in an experimental tractor that develops 3000 lb of drawbar pull (about 20 hp), enough to pull a multiple-bottom plow.

"Fuel cells of the future may provide electric power for homes and factories, vehicles such as trucks and buses, or military weapons and space vehicles," predicts Dr. H. K. Ihrig, vice president and director of research.

The device could be used as a power source for almost any equipment that uses direct current, he explains. Another market for fuel cells could be utility companies that generate direct current. They could use them to supplement conventional powerplants during periods of peak load demand for electricity.

Dr. Ihrig emphasizes that while Allis-Chalmers' fuel cell tractor is of commercial size, it is still a research vehicle.

• **In the fuel cell, fuel gases react with an electrolyte to release a stream of electrons (direct current). A catalyst speeds reaction.**

One of the biggest advantages of the fuel cell is its efficiency in converting chemical energy into usable energy. The best heat engine devised is about 40 per cent efficient. Theoretically, says Dr. Ihrig, the fuel cell is capable of 100 per cent efficiency. The researcher expects to reach 80 per cent efficiency easily with the device. No real attempts were made during the development of the present fuel cells to make them the most efficient, explains Allis-Chalmers.

Another advantage of the fuel cell is that it has no moving parts. The electrolyte is absorbed in a solid material (much like the electrolyte in a dry cell battery) and the gases are bubbled through it.

Fabricating costs for the devices should be inexpensive. Dr. Ihrig says parts for the cells could be stamped out with large tolerances.

Are We

"WE HAVE A PROBLEM. Our consuming population is growing much faster than our producing population."

The company president was talking. He'd called the meeting of his management team to do some long range planning. Until now, everything had sounded rosy. Market research showed that the firm's sales would double by 1967. The company was beginning a long range expansion and re-equipment program. Research was hot on the trail of several developments that promised fine new product potential.

The president continued: "We won't be able to meet our sales and expansion goals unless we have all the men we need. The 1960s can be a soaring decade for us if . . ." The president paused, picked his glasses off his nose, and leaned forward. ". . . If we can find the necessary managerial, technical, and skilled personnel. We'll have the machines, materials, and money. The fourth 'M,' manpower, is the ingredient that may be lacking."

• **Beware**—That scene is being enacted daily. Companies with alert management are concerned about finding enough managerial, and skilled personnel to meet their booming output goals in the coming decade.

STEEL traveled to every major metalworking center in the nation. The editors talked with government officials, recruiters, executive placement firms, personnel managers, trade association officials, college administrators, and officers of professional societies. Here's what we found:

• **Hold Your Hat**—We're headed into the biggest decade the metalworking industries have ever seen. Production in the soaring sixties will dwarf the best years of the fabulous fifties. In 1970, metalworking sales should approximate $300 billion. That compares with $119.5 billion last year.

By 1965, the U. S. population will have grown to nearly 194 million—9 per cent more than today's —with a higher standard of living.

These men are in short supply . . .

- Aeronautical engineers
- Ceramic engineers
- Chemists
- Chemical engineers
- Cost control specialists
- Electrical engineers
- Electronic engineers
- Electronic programers
- Electromechanical engineers
- Engineering technicians
- Industrial engineers
- Marketing managers
- Mathematicians
- Mechanical engineers
- Metallurgists
- Operations research specialists
- Organization planners
- Physicists
- Systems and methods specialists
- Training directors
- Turret lathe operators and other highly skilled workers

And it's tough to fill top posts here . . .

- Accounting
- Communications
- Finance
- Industrial design
- Industrial relations
- Market research
- Personnel
- Purchasing
- Quality control

Source: Haff, Canny, Bowen & Associates, New York; Heidrick & Struggles Inc., Chicago; Labor Department's Bureau of Labor Statistics; STEEL survey of industry and professional associations.

Facing a Manpower Shortage?

By 1965, the labor force will have pushed past the 79 million mark—a gain of 8 per cent over today's. But here's the real problem: The bulk of the growth will be accounted for by women and men under 25. (See chart.)

The prime producing population, men between 25 and 45, will stay almost static. In fact, we'll have 700,000 fewer men aged 24 to 34 in 1965 than we had in 1955. And this is the group from which industry recruits its managerial, technical, and skilled personnel. From 1960 to 1975, we'll have a serious shortage of men aged 35 to 44, the group from which we draw new executives and administrators.

The shocking implication: In 1965, we'll have available about the same amount of specialized manpower as we have today—to turn out 35 per cent more goods and services.

• **No Help Here**—Won't automation compensate for the shortage by freeing production workers to do more highly skilled jobs? Then can we move up the men they replace to technical and managerial posts?

Listen to L. K. Wheelock, executive secretary, Engineering Manpower Commission: "Only 17 per cent of the members of any age group have the ability to complete an engineering education—and half of those are women. From that pool also must come the bulk of the nation's professional and executive personnel."

How about the 45 to 54 age group? Can we rely more heavily on them? For some tasks, yes. But few men at that age can make a successful transition into new fields.

• **Engineering Outlook**—In the last decade, the nation's labor force increased by 21 per cent; the number of engineers and scientists zoomed 75 per cent. The Engineering Manpower Commission (EMC) reports that, today, 1 of every 57 U. S. workers is a scientist or engineer. In 1950, the ratio was 1 to 82; in 1940, it was 1 to 140.

Two important forces have joined to bring about the rapid change: 1. Phenomenal technological advances. 2. Unprecedented international stress. Together, they spell record demand for creative personnel. The demand will churn to a new peak in the early '60s. A survey by EMC indicates that, in 1962, industry will want to recruit 29 per cent more graduate engineers than it did last year. In 1965, industry will want to recruit 40 per cent more.

• **Severe Shortage** — Demand will far exceed the supply. Only about 38,000 engineering students will graduate in 1962. If recent trends continue, less than 80 per cent of them will immediately accept a job. (About 11 per cent go to graduate school, 9 per cent to the military service.) That leaves around 30,000 plus those returning from the military. But industry will be seeking more than 45,000. Add that deficit to an already serious shortage and you see the magnitude of the problem. Worse yet, no relief is in sight. Demand will continue to outrace supply, at least until the late '60s. Examples of racing demand: The Gray Iron Founders' Society estimates its industry will need 2000 more engineers by 1965; it now employs 3500. And remember, the nation loses more than 10,000 engineers annually via death and retirement.

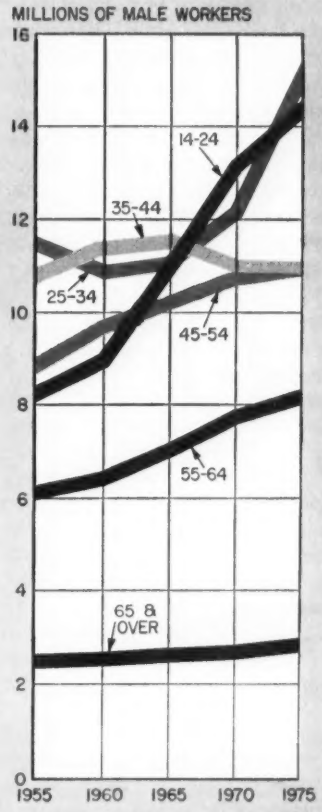
Here's the outlook for B.S. degrees in engineering: 1959—38,900; 1960—41,800; 1961—42,100; 1962—37,900. The number will probably be slightly over 40,000 in '63, '64, and '65. In each year, demand seems certain to exceed supply. The Chase Manhattan Bank has estimated that we'll need 457,000 more engineers in 1965 than will be available.

The shortage will be most severe in the types of engineers important to metalworking: Aeronautical, electrical, industrial, mechanical, metallurgical (see list on Page 96).

Implication: Expect extreme difficulties in hiring new men and a tough battle to keep the men you have. Raiding will be commonplace. It already is becoming a problem. Hoff, Canny, Bowen & Associates, New York executive placement firm, reports that many companies are

Consumers outrun producers . . .

This chart projects the makeup of the labor force by age groups. It points up the manpower crisis: In 1970, there will be fewer men aged 35 to 44 in the U.S. than there are today—and there will be many more jobs to fill. The 25 to 34 age group, from which industry gathers its managerial, technical, and skilled personnel, won't begin to show significant growth until 1966. Crux: A shortage of managerial, technical, and skilled personnel.



Source: Department of Labor, Bureau of Labor Statistics.

having problems because of job hopping engineers and managers. The placement firm notes that the practice is costly to the raiding company because an engineer will often accept an invitation to be wined, dined, and interviewed while having no intention of accepting a job.

• **A Widening Breach** — Today's galloping technology not only stimulates demand for engineers, but it creates a new drain on the engineering manpower pool. Men with technical backgrounds are needed in nonengineering functions. Much of the top talent is siphoned off the engineering pool into areas like marketing, cost control, production—even purchasing and finance.

• **Managerial Shortages** — Metalworking is also having difficulty finding enough managerial talent to go around. As companies expand into new markets, exploit new products, or acquire new affiliates, they are carving out a host of new top echelon positions, notes Heidrick & Struggles, Chicago executive recruiting firm. It reports that demand is at a record high for manufacturing, personnel, and financial executives.

Hoff, Canny, Bowen notes considerable difficulty in finding good cost control people.

Many companies report trouble in locating high caliber marketing managers. And industry's need for better knowledge of its shifting markets is bringing about a shortage of topnotch market research directors.

Efforts to civilize industry's paperwork jungle have brought about a terrific demand for systems and methods specialists. They're in short supply: Industry needs about 2500 more than it has, estimates Systems & Procedures Association of America. And the demand will continue to mount as more companies recognize the cost savings possible in this area: About 40 per cent of the average firm's sales dollar is spent on organization and policy matters. That also brings about a shortage of organization planners. And as companies switch to computers to solve their paperwork problems, the demand for electronic programs skyrockets. This may be the toughest type of man to hire today. Hoff, Canny, Bowen reports three of its clients are looking for 1500 such men and have found less than 50. Other types of managers are in short supply too (see list on Page 96).

• **Skilled Help Problems**—Finding highly skilled workers these days is just as tough as locating crack engineers. Some firms told STEEL that shortages are holding back production. The president of a Chicago metalworking company says his firm's sales outlook justifies expansion of its machine tool capacity, but that won't be done because the firm can't find enough qualified men to run the machines it has.

Bill Wise, personnel manager, Johnson Bronze Co., New Castle, Pa., echoes a common lament: "Our biggest problem is getting skilled tradesmen such as patternmakers, tool and die men, electricians, pipe fitters, and millwrights. I recently tried to get five good men—precision grinders and tool and die specialists. I had to use three-day ad insertions in nine newspapers. The ads drew 300 applicants, but 250 had no qualifications whatsoever."

Even during the recession, manpower was short in 60 skills, reports the Labor Department. In 1956 (the latest year for which full figures are available), the U. S. had no more skilled craftsmen than it did in 1951. And the number of young people entering the field during that time declined 28 per cent.

The Labor Department reports that job openings for skilled workers in August, 1959, were almost two-thirds higher than they were a year earlier. The National Association of Metal Finishers estimates plating firms will need 50,000 new skilled workers next year, 60,000 the year after.

Turret lathe operators are in particularly short supply. Says a Chicago company: "We can't hire a good turret lathe operator who can do his own setup."

• **It's Tough Everywhere**—If shortages of managerial, technical, and skilled personnel don't give you enough of a headache, this note might: Some firms are having trouble finding secretarial help. One company president says this shortage has reached the "critical stage." But most complain only of a lack of well qualified girls.

• **And Competition Is Rougher**—Your personnel department competes with more companies than your sales department does. To get the men you want, you have to do more than beat out other firms in your industry, or in metalworking, or even in manufacturing — you must compete with all business, industry, and government.

And you have more competitors than ever before. Check these examples:

The youthful plastics industry now employs 15,000 engineers; it'll need 25,000 by 1965, reports the Society of the Plastics Industry.

The fast growing instrument industry will be a fierce competitor for manpower. It's investing 6 per cent of the sales dollar in research (vs. a national average of about 2 per cent), reports Scientific Apparatus Makers Association.

"Our industry will need 100 per cent more technically trained people in the next decade," says R. M. Schultz, senior vice president, National Biscuit Co.

General Electric Co.'s needs will rise more than 50 per cent in the coming decade.

"The demand for technicians and engineering helpers will increase well over 100 per cent, possibly 150 per cent, by 1968," estimates W. J. Harshaw, chairman, Harshaw Chemical Co.

"We anticipate tripling our staff of chemical, mechanical, industrial, maintenance, and sales engineers, chemists, and physicists in the coming decade," asserts E. K. Garter, vice president, Garlock Packing Co.

• **What You Can Do**—Against such odds, how can you assure yourself of an adequate supply of managerial, technical, and skilled personnel?

Here is the three-point attack many metalworkers are using: 1. Making more effective use of the men they have. 2. Checking out new sources of supply. 3. Polishing their recruiting and training machinery. STEEL will report on how they're doing it in coming issues.

• This is the first article in a series of four on the manpower shortage and how to meet it. The Nov. 2 article will tell how to make more effective use of the men you have. The Nov. 9 article will deal with exploiting new sources of supply. How to improve recruiting and training will be discussed in the Nov. 16 issue. An extra copy of each article is available until the supply is exhausted. Write: Editorial Service, STEEL, Penton Bldg., Cleveland 13, Ohio.

Robert and Lorraine McDowell have built a giant with a . . .

Turnkey to Contracting

THE MOVE of McDowell Co. Inc. into its new headquarters in Cleveland marks another giant stride in the progress of the youthful engineering and contracting firm. The renovated building, the first curtain wall structure on the public mall, is the latest in a string of innovations which have boosted McDowell from the small shack in which it was founded in 1944 to a prominent place in industrial building.

• **Husband and Wife Team**—Robert and Lorraine McDowell have built up a multimillion dollar enterprise which they eventually plan to call McDowell-Wellman Companies Inc. (McDowell Co. acquired the old, widely known Wellman Engineering Co., Cleveland, in 1954, along with Wellman's producing divisions, Anker-Holth, Locomotive Crane, and Williams Bucket.)

Lorraine McDowell met her husband when he played a leading role in a play she directed at the University of Kentucky. She, in turn, has played an important role in his business career. She is secretary-treasurer of the firm he heads.

The company had earned an engineering reputation even before it assumed the products and processes of its new corporate partners. As a contracting service company, it had attracted attention for some of the unique projects it brought to completion in record time.

• **Unique Methods**—In one, a $20 million, ore unloading dock expansion, plans called for building two new Hulett ore unloaders, moving two more Huletts several miles to the mouth of the Maumee River at Toledo, Ohio, and building auxiliary facilities; the work was done during the winter layup of the lakes fleet with no interruption to shipping. Disdaining the obvious way of moving the unloaders (breaking them into small sections and shipping them), McDowell saved time by disassembling them into several big sections and floating them to the new location by barge.

On a Greenville, Miss., job, McDowell contracted to install two gas lines on a high level bridge. To keep bridge weight within safe limits, McDowell ripped up and replaced the concrete deck, using a borer rig designed for the job. McDowell kept traffic open across the bridge while the job progressed, beat the 166 day deadline by 84 days, and distributed an $84,000 bonus among team members and subcontractors.

Its acquisitions in 1954-55 made the firm an integrated contractor. McDowell now specializes in turnkey contracts, jobs which call for the design, fabricating, and building of finished mechanical plants for steelmaking, metalworking, material handling, mineral processing, and cementmaking.

With the purchase of Wellman, McDowell acquired a number of products which go directly into its plant building jobs. It is now the exclusive builder of the redesigned Hulett unloader; it turns out contractors' clam shell and dragline buckets, air and hydraulic power cylinders, and diesel-electric locomotive cranes.

In 1955, McDowell bought the Sintering Machinery Corp. of New Jersey and, with it, the basic Dwight-Lloyd continuous sintering process for beneficiating mineral ores. Renaming the new associate the Dwight-Lloyd Div., McDowell moved production and laboratory facilities to Cleveland. The McDowell "Flying Saucer" pelletizing pan, for use in agglomerating fine ores or coal fly ash, was developed in the Dwight-Lloyd research laboratory. In its ABCs Scale Div., originally part of Sintering Machinery Corp., McDowell produces belt scales and feeders for its bulk plants.

• **Turnkey Contracting**—In recent turnkey jobs, McDowell has designed and built major sinter plant installations for U. S. Steel Corp., at Chicago and Youngstown, and for Inland Steel Co.'s Indiana Harbor Works. The U. S. Steel jobs were completed in mid-1958; Inland Steel's plant was just getting started when the steel strike closed the mills.

A Patch Job in '60 Congress?

COUNT on Congress to build some fires in the Taft-Hartley area in January, when the second session convenes.

The only thing that will change their minds: Settlement of the steel strike by the industry and the union before a vote is required at the end of the 60 day cooling off period. If the last offer of the industry goes to a vote at the end of the first 60 days of the injunction, as it must under T-H, you can expect fireworks in Congress.

The point: The government went into court for the injunction last week. A vote by the United Steelworkers in 60 days to accept or reject the last offer of the industry would come about the last week of December, just before Congress returns in January. If the result of a vote tends to confuse the situation, then Congress is certain to seek more stable remedies to the sort of impasse in collective bargaining we are experiencing.

A Chat with Fred Hartley

After receiving opinions on the legality of certain sections of the Taft-Hartley Act (see Page 91), STEEL went to one of the authors of the law, former Rep. Fred A. Hartley Jr. of New Jersey, to get his thinking.

About the legality of the vote by the union membership, Mr. Hartley said: "If the law is as weak as your sources at the National Labor Relations Board and Justice Department describe it, then it is much weaker than I intended." NLRB and Justice sources say the vote has no legal standing. They contend: Union leadership is under no legal obligation to follow the mandate of the majority of the union membership, whichever way the membership chooses to vote. Of course, this part of the law has never been fully tested in court.

Queried on what he thought the law meant about the force of the vote by the union membership, Mr. Hartley replied: "It would be a direct violation of the law for the union leadership to call out the strikers even if the vote were only 51 per cent in favor of continuing work." He thought it significant that the union has paid so much attention to "majority rule," yet it is conceivable that Mr. McDonald would not obey the mandate of the voters (his own membership).

What Can Congress Do?

Mr. Hartley and other labor experts in Washington seem to agree: Despite the representatives and senators who owe their allegiance to the labor movement (on the basis of the November, 1958, elections), the next session of Congress will seek some revision of the Taft-Hartley Act. Reason: To protect the country from the type of emergency created by the steel strike.

Compulsory arbitration has been mentioned by more than one resident of Capitol Hill since the breakdown in negotiations. A compulsory fact finding board with the power to make recommendations is another easy solution, suggested several congressmen.

The President's Requirements

One aspect of the situation, which some analysts tend to forget, says Mr. Hartley, is that the President is required under the law to make recommendations to the Congress if the workers do not accept the last offer of the industry and strike again. In a Presidential election year, the requirement puts the Republican administration in a tight spot. The administration may feel that the law has been violated in one way or another, yet it may choose to avoid court action and take its case to the public, through the Congress, by suggesting new legislation.

If the administration agrees with the Presidential board of inquiry members that this situation should never have been allowed to develop, as Dr. Taylor has implied in some of his public statements, then some form of compulsory negotiation will be requested. To do otherwise is to risk the force of public opinion in an election year—something no politician would do even if he were operating on the other side of the moon.

Antitrust Laws for Unions

Mr. Hartley raises this point: If a lockout by a group of employers is to be considered a violation of our antitrust laws, then why isn't an industry strike, as initiated by the powerful steel union, considered an equal violation of the antitrust laws? "There is no equity in the situation," he says.

The possibility of such action is not to be overlooked, he points out. Under the Truman administration, the House passed a law to draft the railroad workers into the Army if they persisted in their strike.

Crux: Congress, under the fire of political motivations next January, can react in a manner which will serve neither industry nor the unions.

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U. S. Halt Hurts UK

British automakers face sheet steel squeeze. Inadequate domestic capacity is blamed

A SHORTAGE of sheet steel, stemming in part from the steel strike in this country, is threatening Britain's booming auto industry.

British sources warn that unless their domestic mills are able to produce more steel, which appears unlikely in the immediate future, all firms may be affected soon, especially if the U. S. strike is prolonged.

Vauxhall Motors Ltd., a General Motors subsidiary, has already eliminated Saturday morning work and plans other cuts over the next three months. The company says 300 cars and trucks a week will be lost, preventing many export commitments from being met.

• **Others Not Hit—Yet—**"The situation is tight, but has not yet affected our operations," reports British Motor Corp. "We are having difficulty obtaining adequate supplies of sheets, but for the moment, we are rubbing along and getting by," reveals British Ford Ltd.

• **British Mills Fail—**Philip Copelin, Vauxhall's chairman, says: "Steel industry officials have indicated domestic mills would be able to supply all car industry requirements by 1959. That has not happened. We have found it necessary to import an increasingly large percentage of our needs." The firm obtains about 25 per cent of its sheets from the U. S., France, and Germany. The company says it would have imported 50 per cent this year if it had been possible. Continental producers have been sending extra shipments to the U. S. since the strike in this country began, aggravating Vauxhall's position.

The British Iron & Steel Federation comments: "The steel industry has been putting in new capacity for sheet production, but has run into teething troubles. It is not coming as quickly as we expected. Although the auto industry is expanding at a tremendous rate, we expect to be able to meet its requirements by the middle of next summer." About 400,000 tons of additional capacity will be needed by that time.

• **Sidelights —** In arguing for the renationalization of the steel industry, the Labor Party has long criticized planning by private enterprise, terming it "inadequate."

Reports from London also indicate the steel shortage is threatening refrigerator production and some other goods for which domestic demand is strong.

Czechs Sign Trade Pacts

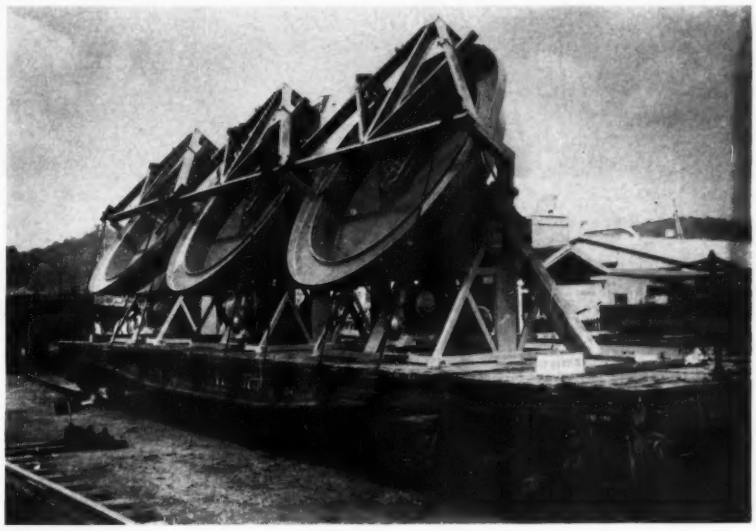
With the conclusion of the First Annual Brno Trade Fair at Brno, Czechoslovakia, last month, it is apparent that the Czechs have had reasonable success with their efforts to establish friendly trade relations with nations outside the Communist bloc.

Major import contracts signed at the fair were for passenger cars from England, France, and Italy, and for special lines from Austria, Italy, and Switzerland for the production of tractors and automobiles. Electronic tubes, regulating and medical equipment, telephones, and textile machinery were also purchased.

Roland Burger, chairman, British Committee for the Development of International Business, said he was pleased with the fair and sees "great possibilities existing in business exchange between Great Britain and Czechoslovakia in engineering products." He added: "I expect future British participation (at the Brno Fair) will be two to three times greater." Britain has already purchased some machine tools from the Red satellite.

Firms from these non-Communist nations sponsored displays: Argentina, Austria, Canada, Belgium, France, Great Britain, Holland, India, Iraq, Italy, Portugal, Spain, Switzerland, Tunisia, West Germany, and the Scandanavian countries. Over 2.3 million people, including 13,000 businessmen and tourists, saw the exhibits.

Czechoslovakia, with over 13 million inhabitants, has made dramatic gains since World War II. Total industrial output was up 326 per cent last year over 1937's, the nation's prewar boom year. Emphasis has been on heavy industry. Consumer goods production has increased 180 per cent.



MIXING DISCS for preparing a mixture of roasted zinc concentrates, fines, flue dust, and coke breeze for agglomeration on sinter machines are shown as they were readied for shipment to St. Joseph Lead Co., Monaca, Pa., from Dravo Corp., Pittsburgh. After sintering, the material will be charged to electric furnaces for reduction to zinc. Each disc can turn out 25 tons of mix per hour. Discs of this type may be used for a variety of mixing or pelletizing applications

Enthusiasm is no substitute

What you want is faster, better blast-cleaning at lowest cost. That's where experience comes in. *Your* experience in using cleaning equipment. *Our* experience making the kind of abrasive you need.

We've been in business for 37 years. We were the first to manufacture steel shot, AMASTEEL, in 1947. We make no other product, we prefer to *specialize* in the manufacture of shot and grit in our electric furnace. More than 25,000 tons a year!

This specialization (experience!), enabled us to develop our secret, two-step quenching process. It makes steel shot and grit of *uniform hardness* with fewer surface pits or cracks. As a consequence, AMASTEEL wears like a pig's nose!

Use AMASTEEL and your machine maintenance will be reduced 60 percent. AMASTEEL cleans faster than other materials, leaves no carbon deposits or metallic residue. Use it, and you can reduce your storage, handling, freight, and dust disposal charges. The savings in your cleaning department can be substantial!

for Experience!

The AMASTEEL engineer-salesman has been into, under and around every kind of blast-cleaning equipment made, for almost as many years as the process has been used in this country. He knows answers to cleaning problems of every description. With the AMASTEEL Process Proving Machine he will test your cleaning operation, supply the right recommendations, and prove them. Right on your desk top! He also has literature describing how AMASTEEL serves other industries like yours. But why wait for his visit? Write or wire for booklet Number 591. It will be sent to you Special Delivery!

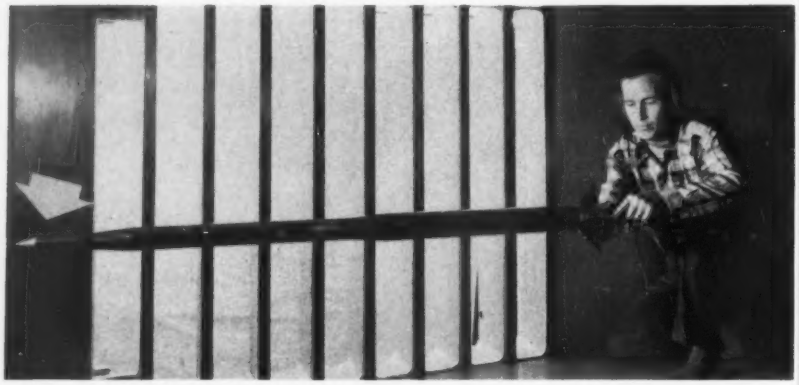
AMASTEEL

ALLOY METAL ABRASIVE COMPANY
121 South Division Street
Ann Arbor, Michigan

"Better Finishing, Faster—With AMASTEEL."

Ablation: Today's Answer to Re-entry

A model of the Mercury man-in-space capsule is exposed to a 5000° F air stream of an electric arc-heated air jet at NASA's Langley (Va.) research center. The actual vehicle will encounter temperatures up to 2600° F upon re-entering the earth's atmosphere



NASA favors the ablation system for cooling the heat shield which protects the capsule. First test of the shield has been termed "highly successful." NASA will use the 71 ft Scout (a model is shown) to test new ablation materials

Possible Solutions

HIGH TEMPERATURE MATERIALS

COATED MATERIALS

HEAT SINKS

TRANSPIRATION

ABLATION

THE NATIONAL Aeronautics & Space Administration opened its doors last week to exhibit important advances in metalworking.

• **Re-entry Material Chosen** — NASA decided upon three preliminary shots of Mercury-type space capsules made of boiler plate, using three different materials as heat shields. (They're called ablative materials, meaning that they are sacrificed to carry away heat.) The shield is one of the most important components of Mercury because the capsule will encounter 2600° F temperatures upon re-entry into the earth's atmosphere.

General Electric Co.'s Missile & Space Vehicle Dept., Philadelphia, and B. F. Goodrich Co., Akron, provided a laminated phenolic glass for the first shot, which was called "Big Joe." Cincinnati Testing Laboratory, Cincinnati, provided another ablative material for a scheduled second shot. Brush Beryllium Co., Cleveland, worked on the beryllium heat sink approach.

STEEL has learned that the first Big Joe, equipped with the Goodrich ablative shields, was so successful that competition among the three materials has been called off.

• **Shield Exhibited**—The exact nature of the phenolic glass material is secret. It worked so well, say NASA sources, that only $\frac{1}{8}$ to $\frac{1}{4}$ in. of the material was lost. (The surface material vaporizes upon re-entry.) One source suggests it might be possible to shave the shield and use it again. It was on exhibit at NASA's Langley (Va.) research center. Charred, glasslike bubbles could be observed on the shield's surface.

The September Big Joe shot involved an Atlas that sent the capsule to a height of 100 miles, even though two of the boosters failed to drop

Heating Problems

Status	NASA's Comments
Protective coatings are necessary	**Tungsten and molybdenum (with melting points above 4000° F) react with oxygen well below their melting temperatures. The result is flaming destruction.**
Promising	**Research is only in its infancy. The coating must satisfy requirements other than heat resistance: It should be sufficiently elastic and not reduce the strength of the base metal.**
Effectiveness restricted to lower speeds	**Beryllium's ability to conduct heat away from the surface (so that it does not melt) drops off rapidly as speed rises above 8000 mph.**
Most effective technique	**A porous material is formed into a container for a low temperature gas like helium, which cools the suface. Plumbing is required for the helium.**
In use	**The surface of the material vaporizes to cool the heat shield. It is not as effective as transpiration, but it does not require plumbing, so offers weight savings.**

off after firing. Planned re-entry velocity was 17,000 mph, but it was not reached, and the capsule fell short of its scheduled impact area. However, the shot was described as a "highly successful, and a severe test of the heat shield." It proved the re-entry capability of the Mercury-type configuration.

• **Other Materials Tested**—NASA is still testing a series of other re-entry materials. Among the top priority programs is a series of experiments in coated materials. In one test a coated material produced results 150 times as good as those of an unprotected material.

Sketchy reports from NASA indicate these materials or combinations have been studied: Teflon over steel, phenolic resin reinforced with Fiberglas, nylon, Haveg's rocketon, ammonium chloride, Lucite, bakelite, asbestos, and polyethylene.

Exhibited by NASA were samples of Teflon heated to 3700° F for 6 seconds, phenolic resin to 3800° F for 5 seconds, nylon to 3800° F for 4 seconds, rocketon to 3800° F for 6 seconds, and Lucite to 3800 °F for 4 seconds.

• **Scout Tests**—NASA plans to use the scout rocket for further re-entry tests of ablative materials. Its nose cone will contain ablation sensors, capable of recording exactly what happens to the material.

Other methods for combating re-entry will continue to be studied by NASA, although the ablation materials have definitely won this round. Transpiration systems (which use gases as coolants) have the most effectiveness at 15,000 mph to 20,000 mph. But plumbing must be added to the system to handle the low temperature gases. The ablation approach is preferred because plumbing increases weight and raises the expense of the system. (Transpiration systems use porous materials, through which the gas is ejected to the surface.)

• **New Shapes, New Materials** — Graphite is receiving special attention from NASA (as well as from the Air Force) because new shapes of re-entry vehicles may demand even better materials than those needed for the Mercury capsule.

One of the difficulties of the Mercury is that it must re-enter the earth's atmosphere through a 7-mile-wide corridor to avoid excessive heating. NASA believes a delta shaped vehicle could safely re-enter through a 60-mile-wide corridor, thus cutting down the guidance problem. But a delta shape would encounter temperatures well above those of the Mercury design in some areas.

The temperature of the leading edges of the craft could exceed 3000° F.

Graphite, perhaps coated with 1/8 in. of pyrolytic graphite, is a possibility for those areas. Greater density graphites than those now available are also needed. A heat shield would serve to protect the other surfaces of a delta vehicle—their temperatures might run about 2200° F. Full scale sections of these vehicles are being tested for structural integrity under intense heat at Langley.

An alternative to the graphite approach may be to build the leading edges of a refractory material with protective coatings.

• An extra copy of this article is available until the supply is exhausted. Write Editorial Service, STEEL, Penton Bldg., Cleveland 13, Ohio. Another article on NASA's work with materials and structures for space vehicles will appear next week.

35% Faster with a BULLARD CUT MASTER Model 75

With their new 76" Bullard Cut Master, Model 75, the Bird Machine Company, South Walpole, Mass., is machining a 39-5/8" diameter stainless steel cylinder frame assembly 35% faster than previously, according to Mr. James Lindsay, General Superintendent.

For the rough cut, removing from 1/8" to 3/16" of stock, the ram and side heads are cutting simultaneously. On the finish cut, .005" deep, only the side head is used.

Accuracy to hold size reduces spoilage. Pendant control reduces operator fatigue. These factors contribute to make these savings possible.

An analysis of your turning, boring, facing and threading operations may show a savings over your present method. Your Bullard Sales Engineer can tell you. Why not ask him?

Or, write

THE BULLARD COMPANY
BRIDGEPORT 9, CONNECTICUT

THE VALIANT may appeal to you as it will to thousands of car buyers. Others may find the body styling of competitive models more to their liking. The serious buyer usually checks on engineering and design features as well. If you're going shopping for a 1960 model car, you'll find a helpful rundown on such features below. Next week, STEEL will publish its annual specifications sheet on dimensions and performance ratings

Design Highlights of 1960 Models

VALIANT is the last of the 1960 models to be introduced. Its 184 in. continental style body is unitized as are all Chrysler Corp. cars with the exception of Imperial.

The 170 cu in. slant six engine turns out 101 hp. A bored out version powers Plymouths and Darts. The cast aluminum intake manifold consists of six long curved branches which supply fuel and air to each cylinder individually. The cast iron block is canted 30 degrees and the water pump is mounted on the side instead of up front.

Instead of a direct current generator, an alternator supplies electrical power on the Valiant (and some Chrysler cars). It provides more current at low engine speeds and is lighter. The alternator's two carbon brushes run on smooth slip rings instead of on a serrated commutator. No current regulator is needed. Six silicon diode rectifiers are mounted on the alternator housing to handle the 12 volt direct current system.

Valiant's manual transmission marks a return to the floor shift. The gearbox is canted 30 degrees to the left and its housing is a one piece gray iron casting, capped with a stamped steel plate. In the three speed automatic shift, a one piece aluminum diecast housing covers transmission and torque converter. The automatic transmission is a scaled down version of Chrysler's TorqueFlite.

• **Corporate Features**—Wiring and cables leading into the passenger compartments of all Chrysler cars are concentrated in one spot and inserted through keyhole grommets. Each item or group of items is grommeted with a rubber block. The blocks are threaded into the large end of the keyhole opening and wedged down into the channel. A vinyl rubber cover plate completes the seal.

Chrysler distributors now have diecast aluminum housings. Lightweight nylon in the moving arm cuts weight and helps boost point life. The company announced its panelescent light for Chrysler and Imperial cars last month (see STEEL, Sept. 14, p. 127). On the safety side, vacuum actuators (they're optional) automatically lock all doors when the engine is started. For emergency stops, a dash switch starts all front and rear turn indicator signals flashing.

• **Novel Mount**—Each of the corporation's V-8 engines utilizes a coil spring on the rear mounting point. Engineers claim it is the first time the device has been used on production cars. Exhaust systems have been rerouted through the propeller shaft tunnel to protect against road damage and to allow the floor to be dropped slightly. Manual seats have four adjusting bolts so they may be raised, lowered, moved forward or back, or tilted. After

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adjustment, the seats can be locked into the most comfortable position. They then are moved forward and back with the regular seat lever.

Major innovation of high performance V-8s is a ram manifold. A column of fuel-air mixture in one of the extended manifold branches keeps moving into the combustion chamber as long as the intake valve is open. The valve motion sets up a compression wave in the manifold tube. The pressure of this wave, pulsating back and forth within the tube, rams air and fuel into the combustion chamber at hundreds of feet per second. Unlike a supercharger, ram induction doesn't use engine power and has no moving parts.

Ford: Major Style Change

Most of the 1960 Ford lines reflect major styling changes, but the company also has made improvements in engineering and component design. Falcon's 144 cu in. engine has overhead valves. The block is gray iron, but Ford has eliminated virtually all cover plates and bolt holes that are potential sources of oil leaks. It has an integrally cast head and manifold which engineers hint will be cast from aluminum later in the model year. The complete economy car engine weighs 345.51 lb, which is roughly 60 lb more than Corvair's aluminum pancake six.

Fenders are bolted onto Falcon's unit body. Rocker panels and underbody box sections are galvanized steel to prevent rust. The dog leg pillar is gone. Like Corvair and Valiant, Falcon has 13 in. wheels.

• **Modifications** — Look for the cross flow radiator on other Ford lines. The top tank is relocated beside the engine so hood height can be reduced. Appearance of T-Birds hasn't been changed much, but an optional sliding roof panel has been added. The convertible has a fully automatic top that's stowed beneath the rear deck. Ford's hardtop convertible, Skyliner, has been dropped from the 1960 lineup because volume didn't support high manufacturing costs.

Mercury has made two barrel carburetors standard on all its 1960 engines to give greater fuel economy. Distributors now have three nylon bearings replacing the single metal bearing support for the distributor plate. The plate slides easily on the bearings, giving more responsive spark advance.

Lincoln has introduced a specially designed rear engine support. Five Butyl rubber cushions on an added cross member are supposed to reduce engine vibration at any speed and deaden rear axle noise in the passenger compartment. The power steering pump has been placed on the crankshaft to eliminate belt slippage and noise. Electrical circuitry is simplified with a central power control box mounted under the hood on the firewall. Like the fuse box in your house, it groups all major fuses and circuit breakers. Printed circuits and multiple connectors ease maintenance.

GM Makes Fewest Changes

Corvair is General Motors' biggest story this year. Its rear engine and transmission, swing axles, and unit body have been much discussed. Don't forget to look at Corvair's gasoline heater that provides 30 second heat and uses the same fuel as the engine.

Pontiac is introducing a redesigned cooling system which employs a divided chamber water pump to distribute water equally to each cylinder block bank.

While most car divisions seem to have switched to the disposable paper air cleaner, Buick is using a polyurethane foam filter element that can be rinsed out and reinstalled indefinitely. Other features include a single transverse muffler which serves dual and single exhaust systems, an adjustable instrument panel that can be tilted for easier reading, and independent heater controls for front and rear seats. An optional photocell device turns on lights at twilight.

Oldsmobile has a redesigned concave piston head which has improved combustion efficiency in its 240 hp Dynamic 88 economy engines. Cadillac has a vacuum actuated parking brake that's automatically released when the car is put into gear while the engine is running. Cadillac also has switched from electrically to vacuum actuated automatic door locks.

AMC, S-P, and Trucks

American Motors seems to have licked its vacuum windshield wiper problems on V-8 jobs with a piston operated booster pump that increases vacuum action even when the throttle is depressed. The American line has added a four door sedan. Door opening angles on the 100 in. wheelbase car have been changed from 55 to 75 degrees to provide easier entry. Another AMC item is a 15.5 lb aluminum housed compressor for the air conditioning system. The old one weighed 34.5 lb.

A redesigned carburetor, improved heads, modified torque converter, and electric windshield wipers are among changes on 1960 Larks. You'll also want to take a look at the Lark convertible, which is the only U. S. built softtop now available in the economy car field.

Outstanding improvements in the truck field are Chevrolet's adjustable leaf springs and torsion bar suspension systems. GMC Truck & Coach Div. has done a real job on its 48 in. long aluminum tilt cab tractor and its V-6 gasoline engines (see STEEL, Aug. 10, p. 95). Front fenders on Dodge trucks swing out 110 degrees and the alligator hood opens 90 degrees for easier maintenance.

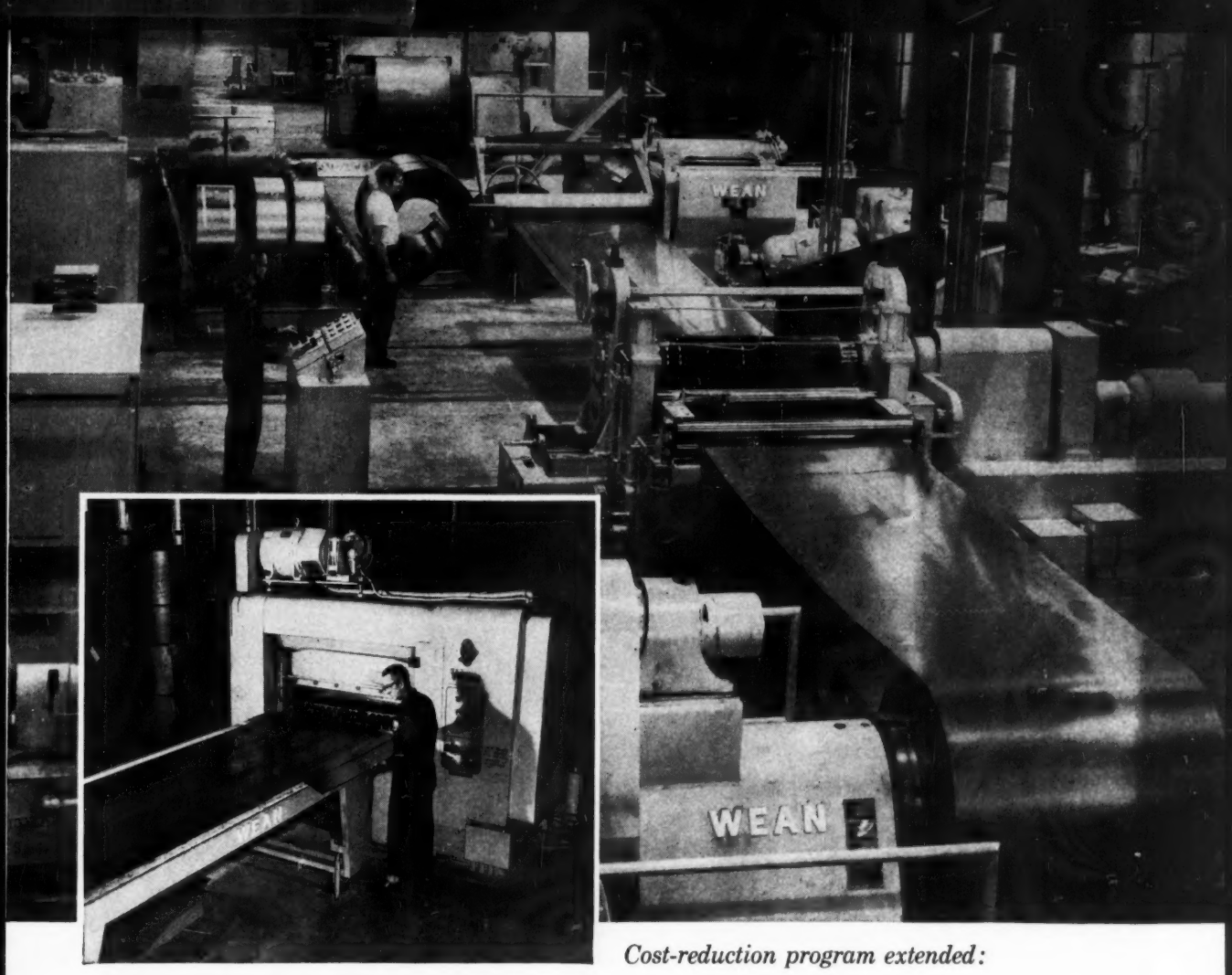
U. S. Auto Output

Passenger Only

	1959	1958
January	545,757	489,515
February	478,484	392,132
March	576,085	357,048
April	578,825	316,594
May	546,817	349,613
June	557,994	337,446
July	555,418	321,017
August	239,152	180,447
September	258,157	130,460
9 Mo. Totals	4,336,689	2,874,272
October		261,701
November		514,152
December		593,920
Total		4,244,045

Week Ended	1959	1958
Sept. 19	62,716	37,150
Sept. 26	91,341	42,599
Oct. 3	105,720	34,464
Oct. 10	118,793	34,834
Oct. 17	135,312†	45,387
Oct. 24	130,000*	70,973

Source: *Ward's Automotive Reports.*
†Preliminary. *Estimated by STEEL.



Cost-reduction program extended:

Lyon Metal Products, Inc., duplicates Wean coil processing lines at second plant

Lyon was one of the first metal fabricators to install its own coil processing equipment. At its Aurora, Ill. plant, Wean slitting and shearing lines were installed in 1953 to supply various sizes of resquared sheet directly from standard coil.

The 6 years' experience with this Wean coil processing equipment has thoroughly proved its economic value to Lyon. Inventory requirements have been reduced and major savings realized in purchased material and labor costs. Mr. J. B. O'Connor, an official of Lyon Metal Products says, "This Wean installation has performed so satisfactorily that we unhesitatingly duplicated it at our York, Pa., plant."

The new Wean equipment at York uses the versatile Wean "Flying Press" to cut lengths of 11" to 96" from slit coil varying in width from 3¼" to 47½". Strip is fed at up to 300 fpm with 1/64" accuracy maintained on all cuts. Lengths are changed many times per shift, the simple adjustments being made by dial settings on the "Flying Press."

If your plant uses large quantities of sheet, you can cut costs by the use of Wean coil processing techniques. An experienced Wean sales representative will be glad to work with you on evaluating just how much you can save: most users have found the pay-off period to be less than two years. We'll be glad to send you more information.

WEAN EQUIPMENT CORPORATION
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WEAN

How steel tubing saves weight in helicopter...in budget, too

Shown below is the main rotor shaft of a new model helicopter. Because it was hollowed out of solid steel bars to save weight, it was costly to make. After machining to thousandths of an inch accuracy, previously undetected steel flaws showed up. One out of every five parts had to be rejected.

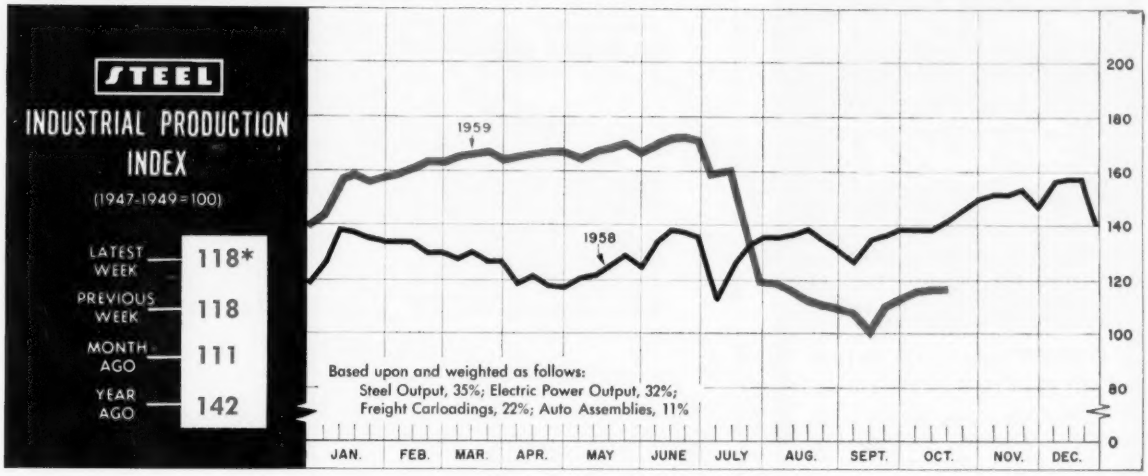
Timken Company Metallurgists were consulted. After careful study, they recommended a special analysis of Timken® seamless steel tubing. Savings began immediately. Because the hole was already there, no drilling was required. Steel was saved. And with the extra advantage of uniform forged quality in Timken seamless tubing, rejects of finished parts were practically nil.

Let us help you cut your costs, get better quality finished products. Our engineers will recommend the most economical tube size for your hollow parts jobs, one guaranteed to clean up to your finish dimensions. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO". *Makers of Tapered Roller Bearings, Fine Alloy Steels and Removable Rock Bits.*

WHEN YOU BUY TIMKEN STEEL YOU GET:

1. Quality that's uniform from heat to heat, bar to bar, order to order
2. Personal attention from the experts in specialty steels
3. Over 40 years experience in solving tough steel problems

TIMKEN ALLOY STEEL AND SEAMLESS STEEL TUBING ARE AVAILABLE FROM WAREHOUSE STOCKS IN 44 CITIES IN THE UNITED STATES



*Week ended Oct. 17.

Slow Upturn in the Offing

YOU CAN EXPECT the general economy to start perking up once most of the nation's steelworkers are back in the mills, but the advance will be slow. Many business indicators will get worse before they get better. And they won't get close to prestrike levels until late in November.

• **Timetable**—Of the four indicators comprising STEEL's industrial production index above, three—steel production, output of electricity, and railroad freight carloadings—have been cut back or held in check by the strike. Carloadings should be the first to respond to renewed steelmaking as producers rush coal and iron ore to their plants.

The improvement in carloadings may start to show up in the statistics for the week ended Oct. 31. The Association of American Railroads claims that in the latest week of record, loadings were down 170,000 cars. Coal, coke, and ore shipments alone have been about 95,000 cars a week under the June level. By mid-November, loadings of miscellaneous freight, which have been running about 50,000 cars below the prestrike average, will pick up significantly if finished steel products begin to refill the pipelines.

Electricity output, which has held up well because of record residential consumption, will inch ahead as the steel mills swing into full production. While national totals may not be influenced greatly, areas such as Pittsburgh, Cleveland, and Chicago will show marked gains.

• **Steel Still Key**—Steel production will have the biggest impact on the index, but the advance will be slow. Electric furnaces will start up first and could possibly be pouring sizable tonnages within a week. But operations by the end of two weeks won't be much more than 40 per cent of capacity, especially if the furnaces are in bad condition. By mid-November, ingot production could be up to 80 per cent. By the

BAROMETERS OF BUSINESS

	LATEST PERIOD*	PRIOR WEEK	YEAR AGO
INDUSTRY			
Steel Ingot Production (1,000 net tons)[2]	510[1]	368	2,026
Electric Power Distributed (million kw-hr)	13,000[1]	13,086	12,048
Bituminous Coal Output (1,000 tons)	7,725[1]	7,645	8,971
Crude Oil Production (daily avg—1,000 bbl)	6,820[1]	6,812	6,893
Construction Volume (*ENR*—millions)	$264.3	$241.5	$248.1
Auto, Truck Output, U. S., Canada (*Ward's*)	164,786[1]	148,239	63,241
TRADE			
Freight Carloadings (1,000 Cars)	560[1]	559	696
Business Failures (Dun & Bradstreet)	274	224	271
Currency in Circulation (millions)[3]	$32,096	$31,933	$31,498
Dept. Store Sales (changes from year ago)[3]	+3%	−2%	+4%
FINANCE			
Bank Clearings (Dun & Bradstreet, millions)	$20,939	$26,086	$19,971
Federal Gross Debt (billions)	$287.7	$288.0	$280.4
Bond Volume, NYSE (millions)	$25.3	$27.5	$33.0
Stocks Sales, NYSE (thousands of shares)	11,543	11,863	24,403
Loans and Investments (billions)[4]	$104.2	$104.3	$94.1
U. S. Govt. Obligations Held (billions)[4]	$27.7	$28.1	$32.0
PRICES			
STEEL's Finished Steel Price Index[5]	247.82	247.82	246.65
STEEL's Nonferrous Metal Price Index[6]	224.8	225 3	210.4
All Commodities[7]	119.1	119.2	118.8
Commodities Other than Farm & Foods[7]	128.5	128.5	126.1

*Dates on request. [1]Preliminary. [2]Weekly capacities, net tons: 1959, 2,831,486; 1958, 2,699,173. [3]Federal Reserve Board. [4]Member banks, Federal Reserve System. [5]1935-39=100. [6]1936-39=100. [7]Bureau of Labor Statistics Index, 1947-49=100.

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Flaw Detector for contact or immersed testing makes a dramatic improvement in the acoustical "picture" of internal structure.

SENSITIVITY reveals 1/64" FBH full-scale at 2.25 and 5.0 mc/s;

RESOLUTION clearly defines 3/64" FBH at 3/16" at 2.25 mc/s in contact testing;

CALIBRATED CONTROLS make it possible to return precisely to previous conditions;

INFINITE CHOICE OF FREQUENCIES without tuning: broad-band receiver adapts automatically to any transducer from 0.4 to 10.0 mc/s;

PYRAMID MARKER with variable delay for precise interpretations with contact or immersed, angle or compression techniques.

SIMPLIFIED CONTROLS, lightweight (37 lbs.), and assured nationwide factory-trained service.

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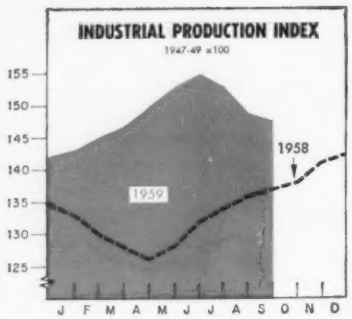
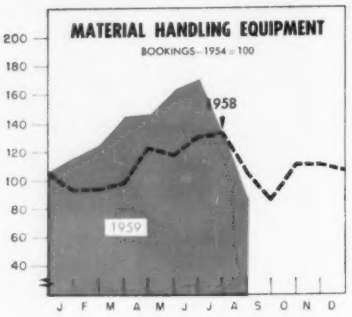
THE BUSINESS TREND





(Seasonally adjusted)

	Total Production 1959	1958	Primary Metals 1959	1958	Metal Fabricating 1959	1958
Jan.	143	133	125	100	166	159
Feb.	145	130	138	95	168	153
Mar.	147	128	146	91	170	150
Apr.	150	126	149	86	173	146
May	153	128	154	91	178	148
June	155	132	150	103	184	151
July	153	134	108	102	186	154
Aug.	149	136	67	109	183	156
Sept.	148*	137	64*	113	183*	155
Oct.	...	138	...	123	...	155
Nov.	...	141	...	123	...	163
Dec.	...	142	...	123	...	165
Avg	...	134	...	105	...	155

Federal Reserve Board. *Preliminary.
Charts copyright, 1959, STEEL.

	1959	1958	1957	1956
Jan.	115.84	93.07	126.34	122.43
Feb.	124.77	93.49	139.29	129.56
Mar.	146.36	97.89	140.76	166.14
Apr.	*147.28	122.36	132.67	145.20
May	164.45	118.04	157.95	155.53
June	170.72	131.15	121.57	189.13
July	130.26	134.34	128.31	165.50
Aug.	87.02	104.46	110.09	168.70
Sept.	.....	85.41	116.79	130.35
Oct.	.....	111.35	124.80	143.38
Nov.	.....	110.88	87.80	138.50
Dec.	.....	105.97	105.65	117.76
Avg	.....	109.87	124.34	147.68

Material Handling Institute Inc.

end of November, the industry could approach its record set last spring.

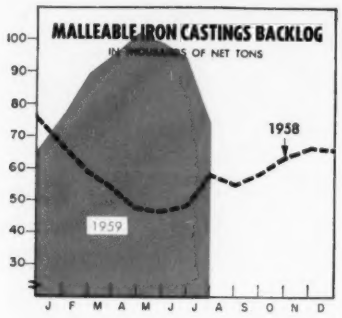
• **Jokers in the Deck**—STEEL's index may show a slight gain in October, followed by a steady rise in November to somewhere around the 160 level (1947-49 = 100) by Thanksgiving. Two big ifs: 1. If the steelworkers make an honest effort to produce in the next couple of months. 2. If auto producers can hold out until finished steel starts coming from the mills.

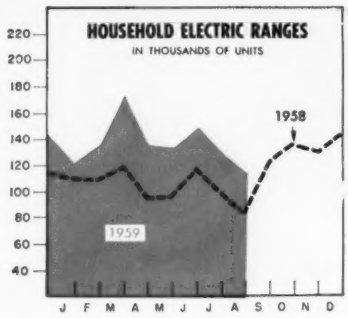
In motordom, it appears that only the Little Two will get through the whole period without feeling a steel shortage. General Motors has cut back drastically on its big seller, Chevrolet, and may have to slow down on some of the other makes before help arrives. Chrysler has made some minor adjustments in schedules and claims it can go through the middle of next month. With luck, any further adjustments may still be minor. Ford claims it can go through another three weeks without trouble, which means some slowdowns or cutbacks will be necessary about Nov. 15, if not before.

FRB Index to Drop, Rebound

Any back-to-work move now, coming so close to the end of the month, will have little influence on the Federal Reserve Board's industrial production index for October. It slipped another point in September to 148 (1947-49 = 100), bringing the total decline since the start of the strike to 7 points. (See graph and table above.) Metal fabricating, which makes up a large part of the index, managed to hold even last month, but it undoubtedly declined this month as metal shortages caught up with metalworkers. The slight increase that could be marked up in primary metals (which constitutes about 5 per cent of the index) will hardly be enough to offset the decline in metal fabricating. Result: Look for another drop of a point or two in the FRB index for this month.

But look for a sharp gain in November. A major portion of the ground lost in the primary metals segment will be restored. Metal fabricating may start off slowly next month as metal stocks shrink, but once the pipeline starts to function, durable goods output will jump. Nondurable goods production has remained strong throughout the year and will get stronger leading up to Christmas. Result: The FRB index for November should register be-





	Shipments 1959	Shipments 1958	Unfilled Orders* 1959	Unfilled Orders* 1958
Jan.	73.2	62.7	77.3	67.3
Feb.	74.8	54.7	90.3	59.0
Mar.	84.3	51.7	95.8	54.3
Apr.	91.0	50.7	102.5	47.7
May	83.5	48.3	99.9	46.6
June	85.5	51.9	95.3	48.3
July	69.2	41.9	75.3	58.3
Aug.	...	49.3	...	55.1
Sept.	...	56.8	...	58.4
Oct.	...	61.0	...	63.4
Nov.	...	63.4	...	66.7
Dec.	...	68.4	...	65.9
Total	...	660.8		

*For sale. U. S. Bureau of the Census.

	Total Factory Sales—Units 1959	1958	1957
Jan.	120,800	109,000	144,500
Feb.	134,600	108,700	127,700
Mar.	172,600	117,900	139,400
Apr.	136,100	95,600	107,200
May	133,400	96,000	93,600
June	151,400	116,800	102,300
July	129,200	98,500	88,700
Aug.	116,600	81,400	85,800
Sept.	.....	121,800	124,800
Oct.	.....	135,500	120,400
Nov.	.....	129,000	116,800
Dec.	.....	143,900	113,800
Totals	.....	1,354,100	1,365,000

National Electrical Mfrs. Assn.

tween 150 and 152 compared with the June record of 155.

Too Late for GNP Goal

Renewed steelmaking will come too late for the gross national product to reach a $500 billion annual rate in the fourth quarter. If the steelworkers walk out again in January, the goal probably won't be realized in 1960's first quarter.

While on the subject of GNP, it is interesting to note that the Republican Party's Committee on Program & Progress predicts it will reach $900 billion by 1976—predicated on an average growth rate of about 4 per cent a year. The committee also sees a population of 240 million, with a work force of about 105 million. (Present population is about 178 million and labor force is about 72 million.)

Profits Take Beating

The strike has taken its toll of metalworking's profits and probably will take more in the fourth quarter. While the third quarter is traditionally the slow one, many of the early reports indicate that profits would have been higher were it not for slowdowns in production and cutbacks in orders attributed to the steel strike. While earnings in many cases are above those of the corresponding quarter of 1958 (the first full quarter of the recovery), a significant number have slipped more than seasonally below the previous quarter's income. And more often than not, executives declare fourth quarter profits depend on steel supplies, which will be short in many cases.

But Job Outlook Brightens

However, many companies evidently are planning on high level operations this quarter. A survey of employment by Manpower Inc., Milwaukee, reveals that 23 per cent of the 2500 respondents plan to increase payrolls before the end of the year. There was some caution in foundries, steelworks, and rolling mills, but metal users were more optimistic.

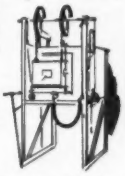
Of those surveyed, 29 per cent of the machinery manufacturers, 18 per cent of the electrical appliance makers, and 17 per cent of the agricultural equipment and tractor manufacturers look for employment increases.

Optimism was high in the service fields—bankers, insurance companies, printers, advertising concerns —and in retailing.

WALTER CLEMONS, Furnace Application Engineer, says . . .

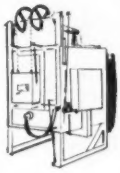
LET'S TALK ABOUT FURNACE FLEXIBILITY

Versatility of Operation multiplies the value and economy of Hayes Type LR Preheat and Type CG Superheat Furnaces...designed to handle almost limitless hardening and annealing applications. With Hayes external generating equipment, these two standard furnaces are also adaptable to reducing as well as oxidizing atmospheres . . . for treating virtually all types of steels and many non-ferrous metals.



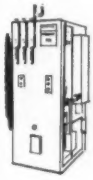
Hayes Type LR Preheat Furnace — Standard Temperature Range 1350-2000° F

"Spare-Tire" Furnaces, they're often called—because each features Hayes patented "Certain Curtain" atmosphere control, ready to act as a stand-by when the external generator is not in use. Muffle and preheat chamber can be added easily for critical heat treating jobs requiring low dewpoint atmospheres.



Hayes Type CG Superheat Furnace — Standard Temperature Range 1600-2400° F

Results Guaranteed! If you're looking for quality, economy, *plus* furnace flexibility . . . let Hayes engineers go to work for you. You'll get complete service right from our laboratory to your production line.



Hayes Type IGL Endothermic Generator — for reducing and carbon potential atmospheres. Sizes from 100 to 20,000 CFH.

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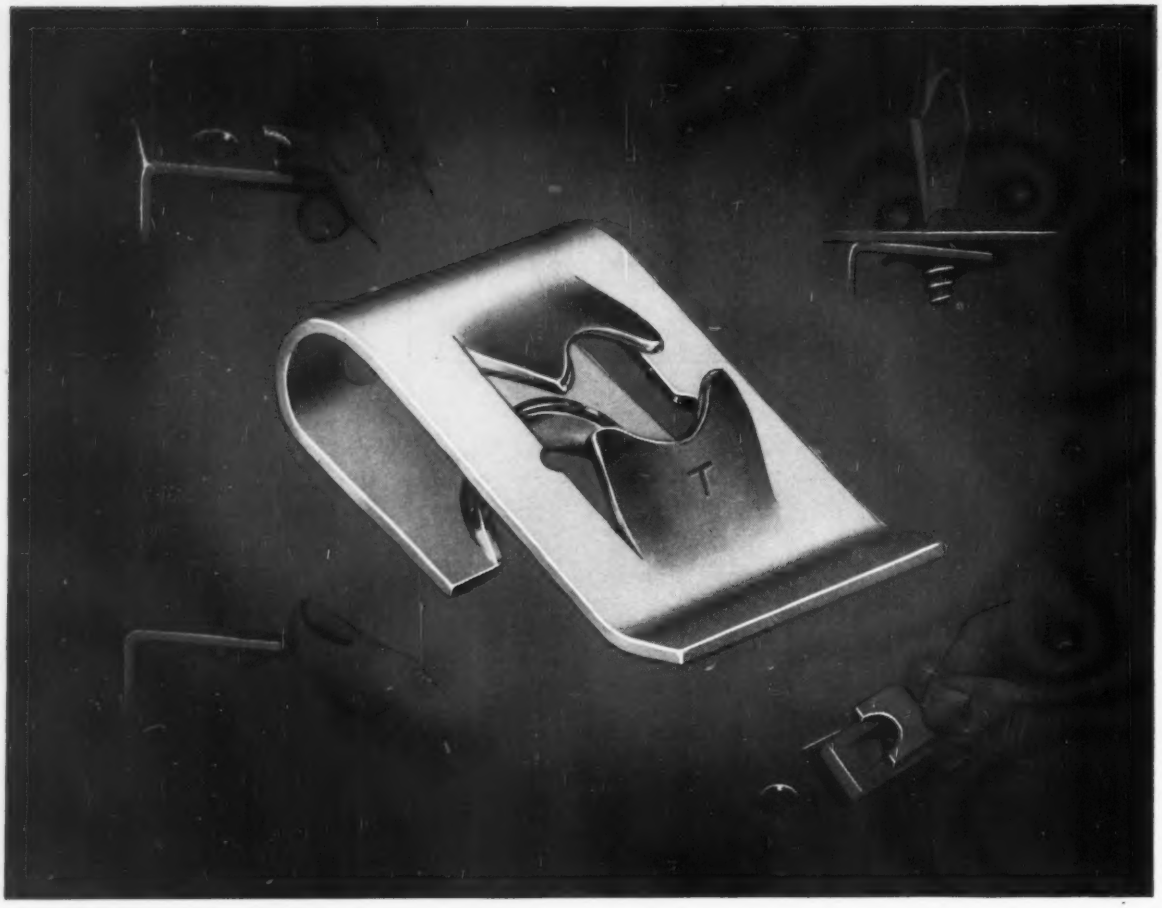

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SPEED NUTS are ideal for blind assembly or hard-to-reach locations. Apply them *before* you paint panels without danger of paint-clogging. Or *after* porcelainizing, without damage to finishes. The "U" type is similar to the "J" type, shown above, but is used where full bearing surface on the lower leg is required.

A free Fastening Analysis can tell where SPEED NUT brand fasteners belong on your products. Call your Tinnerman representative—he's listed in most major telephone directories. Or write to:

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EDMOND H. JUDD
Associated Spring factory mgr.

ROSS W. COLEBROOK
National Supply eng. post

E. WAYNE ALLEN
Diamond Chain dir.-purchases

ROBERT D. GUENTZLER
Electric Products p. a.

Edmond H. Judd was appointed factory manager, Gibson Div., **Associated Spring Corp.** He is responsible for manufacturing operations at the division's new plant in Mattoon, Ill., now nearing completion. Mr. Judd was in charge of tooling, Flat Dept., Wallace Barnes Div.

Ross W. Colebrook was appointed chief engineer-hydraulic drives for **National Supply Co.** His headquarters are at the company's Technical Center, Allison Park, Pa., near Pittsburgh.

Karl A. Gardner was made vice president-engineering, **Yuba Consolidated Industries Inc.** He has headquarters at the Yuba Engineering & Marketing Development Center, Palo Alto, Calif. Mr. Gardner was chief engineer, Griscom-Russell Co., Massillon, Ohio.

Frank Jolliffe was made assistant to the president, a new post at **Hanna Furnace Corp.**, Detroit, a division of National Steel Corp.

Marion J. Kolasa was made Detroit district manager, **Sturtevant Div.**, Westinghouse Electric Corp.

Richard P. Simmons was named manager of quality control by **Latrobe Steel Co.**, Latrobe, Pa. He was manager of processing, Titanium Metals Corp. of America.

George Main was appointed assistant sales manager, **Arwood Precision Casting Corp.**, New York. He was manager of Howard Foundry Co.'s Hartford, Conn., sales office.

E. Wayne Allen was named director of purchases, **Diamond Chain Co. Inc.**, Indianapolis, subsidiary of American Steel Foundries. He joined Diamond in 1943.

Joseph N. Guest was made production manager, **Kidd Works**, Aliquippa, Pa., Vulcan-Kidd Steel Div., H. K. Porter Company Inc. He succeeds **J. Ernest Hinzman**, recently made manager-research and development for the division.

Thomas E. Spence was made vice president-engineering; **F. Russell Smith** chief engineer of **Nice Ball Bearing Co.**, Philadelphia, a division of Channing Corp.

Robert F. Moody, former sales manager, Industrial Truck Div., **Hyster Co.**, moves from Danville, Ill., to headquarters in Portland, Oreg., as general sales manager.

Raoul D. Elder was appointed sales manager, **Aurora Pump Div.**, New York Air Brake Co., Aurora, Ill. He succeeds **John M. Bals**, now general manager of the division.

John E. Ripple was made superintendent of **Alan Wood Steel Co.**'s blooming mill and plate mill, Conshohocken, Pa. He succeeds **Frank J. Bampton**, transferred to the Engineering Dept.

Walter A. Scrivens was made director of manufacturing, **REF Mfg. Corp.**, Mineola, N. Y. He was vice president-general manager, Auth Electric Co. In his new post, he supervises production as well as purchasing and personnel relations.

Robert D. Guentzler was made purchasing agent, **Electric Products Co.**, Cleveland. He held a similar post at Cleveland Electronics Inc. for ten years and previously was with Cleveland Diesel Engine Div., General Motors Corp.

Robert M. Snow was made acting manager, Applied Science Div., **Melpar Inc.**, Falls Church, Va., subsidiary of Westinghouse Air Brake Co. Former assistant manager, he succeeds **Dr. Thomas P. Cheatham Jr.**, now special adviser to the vice president-research and engineering.

George L. Innes was made director-sales and development, **Michigan Chemical Corp.**, St. Louis, Mich.

Lloyd A. Amos was appointed manager of operations, **Kaiser Aluminum International.** He will have headquarters at Oakland, Calif., Kaiser Aluminum & Chemical Corp.

Andrew T. Marchuk was named director of marketing, **Sherman Products Inc.**, Royal Oak, Mich. He was with Sauerman Bros. Inc.

James R. Bonnington was made manager of byproducts for **Chrysler Corp.**'s Purchasing Dept., Detroit. He is responsible for sale or disposal of all surplus, salvage, or obsolete materials, equipment, machinery, and facilities.

Arthur W. Gittins was named division superintendent of primary production at **Wheeling Steel Corp.'s** Steubenville, Ohio, Works. Before joining Wheeling Steel, he was as-

GLENN E. KUHN
R. D. Werner p. a.

L. A. DAVIS
Union Wire Rope sales post

HENRY A. ROEMER JR.
Pittsburgh Metallurgical post

BUDD L. MACK
Budd electronic controls post

sistant superintendent of Hanna Furnace Corp., Buffalo.

R. D. Werner Co. Inc., Greenville, Pa., appointed **Glenn E. Kuhn** purchasing agent, and **James D. McKay** sales manager, Industrial Div. Mr. Kuhn was superintendent of Plant 1 in Greenville.

L. A. Davis was made manager-wire sales, **Union Wire Rope Corp.**, Kansas City, Mo., subsidiary of Armco Steel Corp.

Donald K. Ballman and **C. B. Branch** were elected vice presidents, **Dow Chemical Co.**, Midland, Mich.

W. Donald Osborne, works manager, Gar Wood Industries, was appointed Minneapolis works manager of **Minneapolis-Moline Co. L. E. Petter**, product manager, was named supervisor of product planning for the company. **Thomas R. Mortimer** was promoted to sales specialist at Minneapolis-Moline general offices, Hopkins, Minn.

Henry A. Roemer Jr. was appointed sales manager, **Pittsburgh Metallurgical Co. Inc.**, with headquarters in Pittsburgh. He has been Cleveland district sales manager since joining the firm earlier this year.

Ted A. Rohlfsen was made South Pacific Coast Div. manager of **Oakite Products Inc.**, Los Angeles. He succeeds **J. C. Leonard**, retired. Mr. Rohlfsen joined Oakite in 1947

William J. Parsons was appointed senior vice president, Industrial Div., **Pacific Scientific Co.** He continues headquarters at the Los Angeles facility of the company where he will supervise and co-ordinate activities of the division.

P. E. Taylor was made vice president-sales, **Smith Welding Equipment Corp.**, Minneapolis. He was vice president in charge of production and personnel. **D. B. Moline** was made advertising and sales promotion manager.

Budd L. Mack was promoted from district sales manager to sales manager, Electronic Controls Section, **Budd Co.** He is at the Hunting Park, Pa., plant. Mr. Mack joined the section last May following a year as director of marketing for Holliday-Hathaway Co. and four years as regional sales manager of American Electronics Inc.

Wilder E. Perkins was made factory manager, **Manhattan Rubber Div.**, Raybestos-Manhattan Inc., Passaic, N. J. He was co-manufacturing general manager with **R. J. Gorecki** who has resigned. **A. J. Van Benschoten** was made division purchasing director; **G. Hellerman** manager of traffic and transportation.

Frank Colbourn was appointed general manager of **Rotex Punch Co. Inc.**, San Leandro, Calif. He was vice president, S. F. Stores Div., Moore Machinery Co.

Robert W. Neitzel succeeds the late **W. W. Stewart** as controller of **Hy-**

W. DONALD OSBORNE
Minneapolis-Moline works mgr.

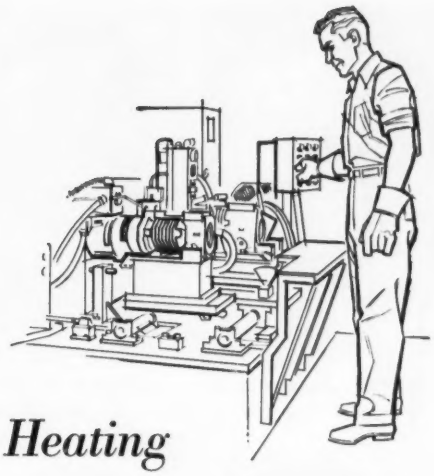
WILLIAM J. PARSONS
Pacific Scientific exec.

P. E. TAYLOR
Smith Welding sales v. p.

FRANK COLBOURN
Rotex Punch gen. mgr.

How a **Shrink-Fit** E-x-p-a-n-d-s Profits

Copeland Saves $100,000.00 A Year



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Press-Fit Method

In the assembly of motor-compressors for their air conditioning and refrigeration products, Copeland Refrigeration Corporation formerly employed air presses for force-fitting their 1/5 HP through 1½ HP motor housings and stators. This method was costing Copeland $100,000.00 annually in labor, material and quality control expense to maintain the high quality of its product.

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To reduce these costs, Copeland installed a 30 kw, 10,000 cycle TOCCO Induction Heating Unit. Motor housings are heated to 400° F. resulting in up to .013″ expansion. After cooling, the motor housing shrinks to form a predictable and perfect fit with the stator. Stator scoring and distortion are eliminated and $100,000.00 annual saving realized.

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Name_____

Position_____

Company_____

Address_____

City_____ **Zone**____ **State**_____

HARRY W. McLAUGHLIN JR.
American Forge exec.

ROBERT B. MENEILLY
U. S. Steel position

HANS W. DEUTSCH
Scully-Jones div. mgr.

HERBERT I. CHAMBERS
DataTape associate dir.

DR. JOHN L. ZAMBROW
Sylvania-Corning eng. dir.

GEORGE E. BARTLETT
Moog engineering manager

draulic Press Mfg. Co., Mt. Gilead, Ohio.

Herbert I. Chambers was made associate director, **DataTape Div.**, Consolidated Electrodynamics Corp., Pasadena, Calif., responsible for activities of the Engineering Dept., Special Projects Dept., and Magnetic Head Section of the division. **Fred F. Grant** was made manager, Engineering Dept.; **Edgar E. Hotchkin** manager, Magnetic Head Section.

Anthony L. Barclae was promoted from sales engineer to sales manager, **Saco-Lowell Automotive Div.**, Boston, Saco-Lowell Shops.

Edward E. Franks Jr. was made Chicago district sales manager, Machine Div., **Torrington Mfg. Co.** He was chief engineer of the division.

Cole H. Pilcher was made vice president-industrial relations, **ACF Industries Inc.**, New York. He held a similar post with Sylvania Electric Products Inc.

Dr. John L. Zambrow was made director of engineering, **Sylvania-Corning Nuclear Corp.**, Bayside, N. Y. He was manager-Metallurgy Dept.

George E. Bartlett was made engineering manager, **Moog Servocontrols Inc.**, East Aurora, N. Y. He had been with Cornell Aeronautical Laboratory as administrative engineer, Aerodynamics Research Dept.

William H. Lang was elected administrative vice president and treasurer, **United States Steel Corp.**, Pittsburgh. He succeeds **Howard E. Isham**, vice president-treasurer, who retires Nov. 30.

Richard W. Stevens was elected a vice president of **Milwaukee Boiler Mfg. Co.**, Milwaukee.

Dr. John E. Cox was made director of research and development, Porcelain Enamel Frit Div., **O. Hommel Co.**, Pittsburgh. He was senior research fellow at Mellon Institute for the company.

Harry W. McLaughlin Jr. was named secretary and assistant to the president of **American Forge & Mfg. Co.**, McKees Rocks, Pa. He has been general manager since 1957.

Robert B. Meneilly fills the new post of general manager-tin mill products, **United States Steel Corp.**, Pittsburgh. He administers a coordinating service for executive vice presidents—commercial, production, and engineering and research. He was manager-tin mill products and is succeeded by **Donald K. Wright**, former assistant manager.

Hans W. Deutsch was made manager, Special Products Div., **Scully-Jones & Co.**, Chicago. In addition to duties as manager, he will work directly with Scully-Jones customers on design problems.

Austin R. Zender, chairman and chief executive officer, **Mallory-Sharon Metals Corp.**, Niles, Ohio, was elected president to succeed **Frank H. Vandenburgh**, resigned. **Eugene J. Cronin Jr.**, who was administrative assistant to Mr. Zender, was named vice president-general manager.

Charles N. Chalfant was promoted to senior product manager-metal finishing, **Kelite Corp.**, Berkeley Heights, N. J. He was product manager-metal finishing. He will continue to have field responsibilities for metal finishing sales.

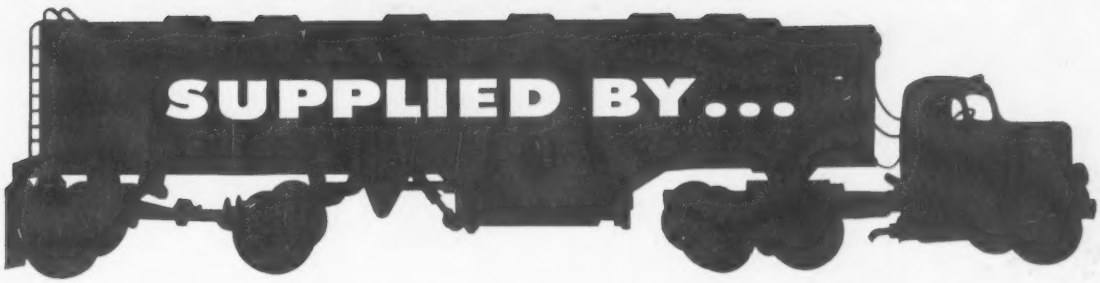
George W. McGinley was made sales manager of **Stromberg-Carlson Div.**, San Diego, Calif., General Dynamics Corp.

Francis G. Kirschner was made chief engineer, Acoustical Div., **Korfund Co. Inc.**, Long Island City, N. Y.

William W. Wellborn was made vice president and director, research and product development, **Abrasive Dressing Tool Co.**, Detroit. He was technical director, Powdered Metals Div., Firth Sterling Inc.

OBITUARY...

Raymond A. Thon, former director-quality control, Rochester, N. Y., Products Div., **General Motors Corp.**, died Oct. 6.



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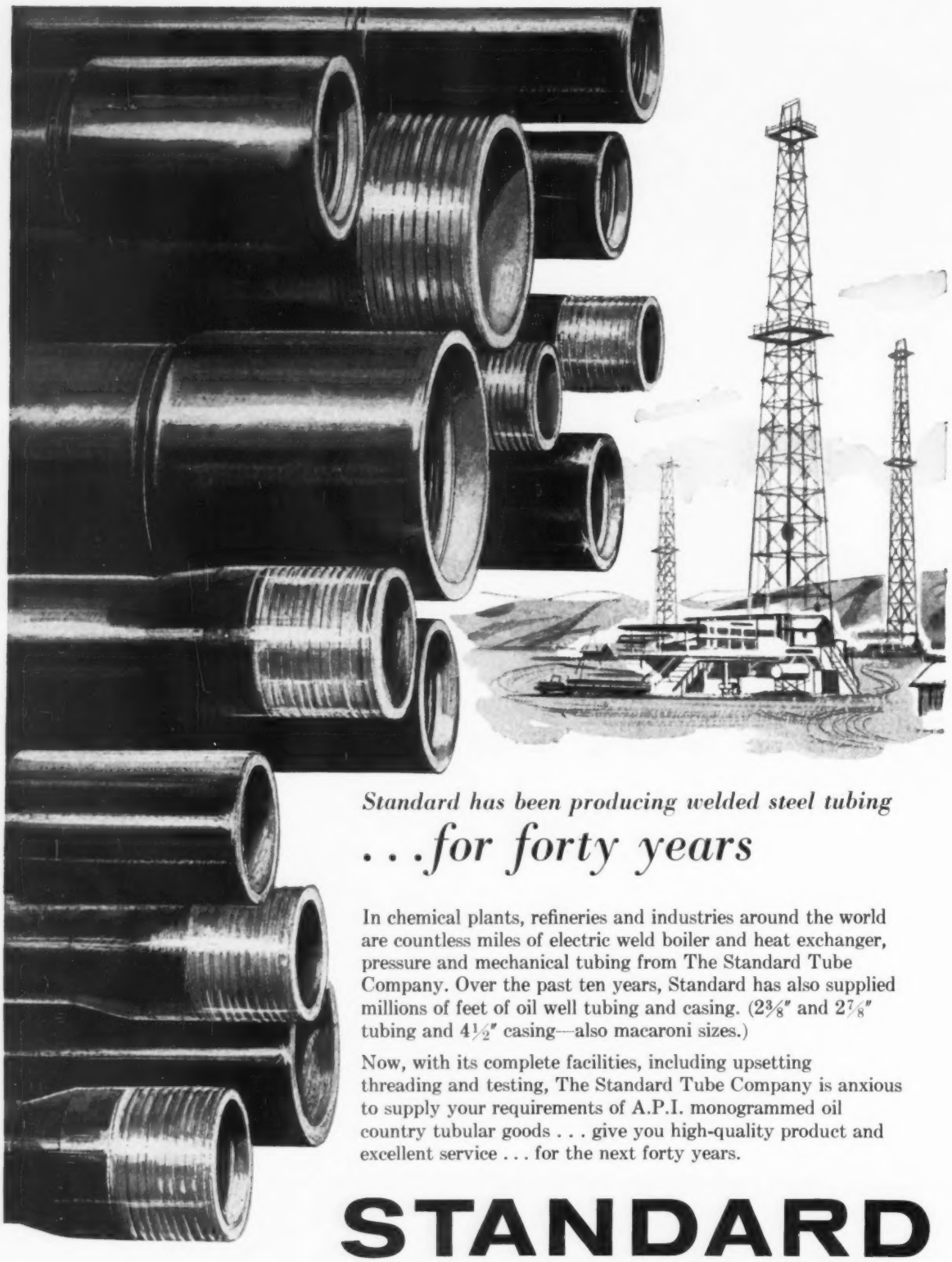

Standard has been producing welded steel tubing

. . . *for forty years*

In chemical plants, refineries and industries around the world are countless miles of electric weld boiler and heat exchanger, pressure and mechanical tubing from The Standard Tube Company. Over the past ten years, Standard has also supplied millions of feet of oil well tubing and casing. (2⅜″ and 2⅞″ tubing and 4½″ casing—also macaroni sizes.)

Now, with its complete facilities, including upsetting threading and testing, The Standard Tube Company is anxious to supply your requirements of A.P.I. monogrammed oil country tubular goods . . . give you high-quality product and excellent service . . . for the next forty years.

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Welded stainless tubing and pipe • Welded carbon steel mechanical • Boiler and Heat Exchanger
Exclusive rigidized patterns • Special Shapes • Oil Well Tubing and Casing
Light Weight Pipe • Steel Tubing—Sizes: ½″ OD to 6″ OD—.028 to .270 wall
Stainless Pipe and Tubing—Sizes ¼″ OD to 4¾″ OD—.020 to .187 wall.

TUBE TALK

The Standard Tube Company is the first specialty tube mill to enter production of finished oil well tubing and casing to the precise requirements of American Petroleum Institute Spec. 5-A. **API monogram rights** were granted to us in 1957 and since then millions of feet of our electric welded tubing is in successful service in producing wells.

Perfect reliability of the weld is a must in oil wells as the failure of a single tube deep in the ground can cost thousands of dollars to remove—or even lose the well. Standard is used to this kind of responsibility as we have, for many years, produced electric welded tubing for automobile propeller shafts, high pressure boiler tubing and heat exchanger tubing, where failure of a single inch of the welded tube could cause extensive property damage or perhaps the loss of human life.

High strength (55,000# p.s.i. minimum yield) requiring higher carbon steels is a necessity as thousands of pounds of tubing hang unsupported on the first threaded joint. Standard has had vast experience in producing high strength electric weld tubing and upsetting the ends to give added wall thickness where it is needed.

Accuracy of machined threads to precise API dimensions and **thorough inspection methods** are required so that long strings of tubing can be put together and lowered into the well from the derrick without trouble. Precision work in quantity production is an every day routine at Standard.

Consult us on your tubing requirements. We may be able to save you money by perhaps the use of higher strength steels, upsetting, flaring or reducing, drawing to close dimensions, replacing bar stock with tubing and many other possibilities. See our range of products at left.

Please write to me and let me know how Standard can be of service to you.

THE STANDARD TUBE COMPANY

LELAND M. HOGAN
Vice-President

Bridgeport Brass Buying Control of Seymour Mfg.

BRIDGEPORT BRASS CO., Bridgeport, Conn., is purchasing controlling interest of Seymour Mfg. Co., Seymour, Conn. The purchase contract is subject to court confirmation of the right of trustees to sell certain securities under the wills of G. E. and A. W. Matthies.

Austin R. Zender, Bridgeport Brass president, points out that although his company is a large manufacturer of nonferrous metals, Seymour has special machinery and equipment for the manufacture of nonferrous alloys which Bridgeport does not produce. Those facilities will permit Bridgeport to enter new fields in the nonferrous industry, including the production of special phosphor bronze and nickel silver alloys, nickel anodes, and bright nickel solutions. Seymour also makes stainless steel items.

Bridgeport Brass has entered into a contract with the government to purchase a Navy owned plant in Warren, Ohio, in which it will install machinery and equipment for the manufacture of aluminum products, including sheets and strip.

The company also has renewed its lease on the U. S. Air Force owned plant at Adrian, Mich., where the company makes aluminum forgings, extrusions, rods, and tubes.

Renews Smelter Plans

Aluminum Co. of America, Pittsburgh, will partially resume construction on certain long term phases of its aluminum smelter at Warrick, Ind. The $80 million project had been planned with four aluminum reduction potlines having a smelting capacity of 150,000 tons a year. Construction was slowed during the 1957-58 business recession, was suspended last June. It may be resumed early in November.

"We want to bring the facility closer to completion so it can get underway in minimum time should conditions improve sufficiently to warrant such action," says J. R. Ibach, works manager. The company says eventual startup of the works will be controlled by general business conditions, prospects for improved aluminum demand, and the duration of the steel strike.

Bendix Gets Alloy Rights

Bendix Aviation Corp., Detroit, has been licensed by Magnesium Elektron Ltd., Manchester, England, to make and sell in the U. S. castings produced by Magnesium Elektron's techniques. They involve use of fluoride-base alloying materials. The alloys are used in such applications as castings for jet engine compressors, jet engine expansion chambers and gearboxes, and high pressure hydraulic equipment for missiles and other high performance aircraft.

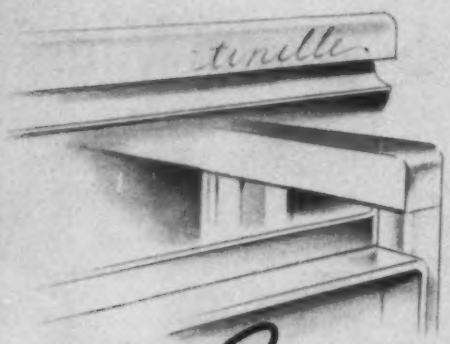
Buys Ilmenite Property

Glidden Co., Cleveland, acquired a large deposit of high grade ilmenite ore in Ocean County, New Jersey. The ore is the principal raw material used in making titanium dioxide. Glidden will operate a mine at the site to supply a substantial portion of its ilmenite ore needs. A concentrating and separating plant will be built on the property and is slated for completion late in 1961. Richard Quirk is manager of the new operation.

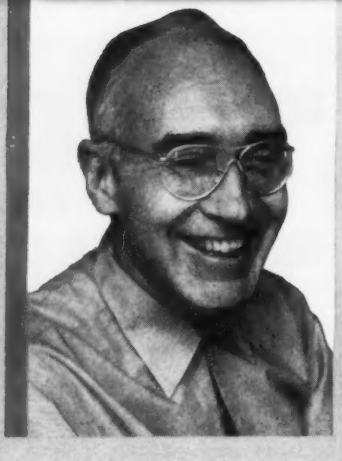
May Build Oxygen Plant

Linde Co., a division of Union Carbide Corp., New York, plans to build a $1 million plant to supply oxygen for the open hearth plant of Youngstown Sheet & Tube Co.'s Campbell Works, Campbell, Ohio. The plant initially would produce about 100 tons daily, but could be increased to 500 tons. Approval

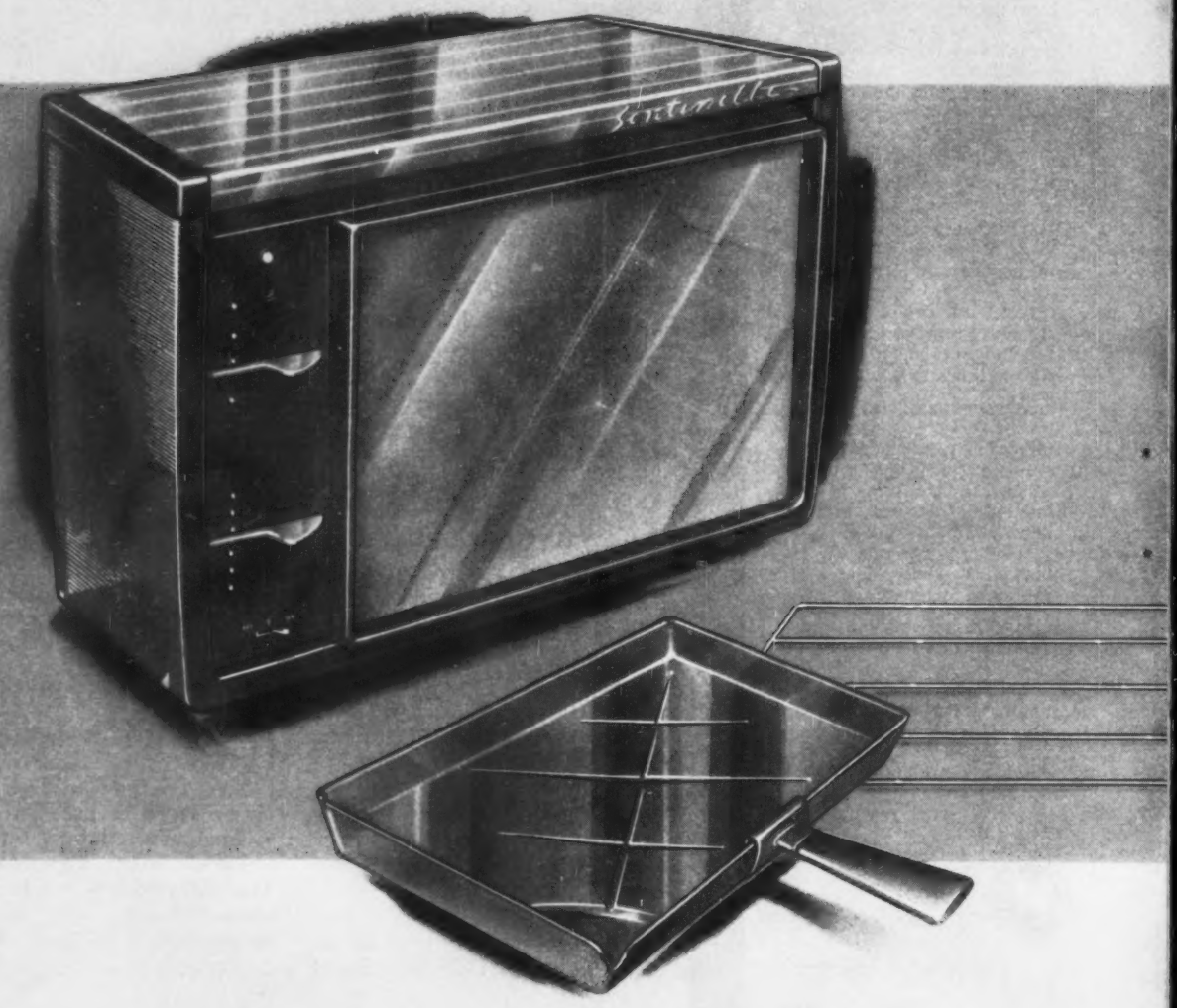
(*Please turn to Page* 126)

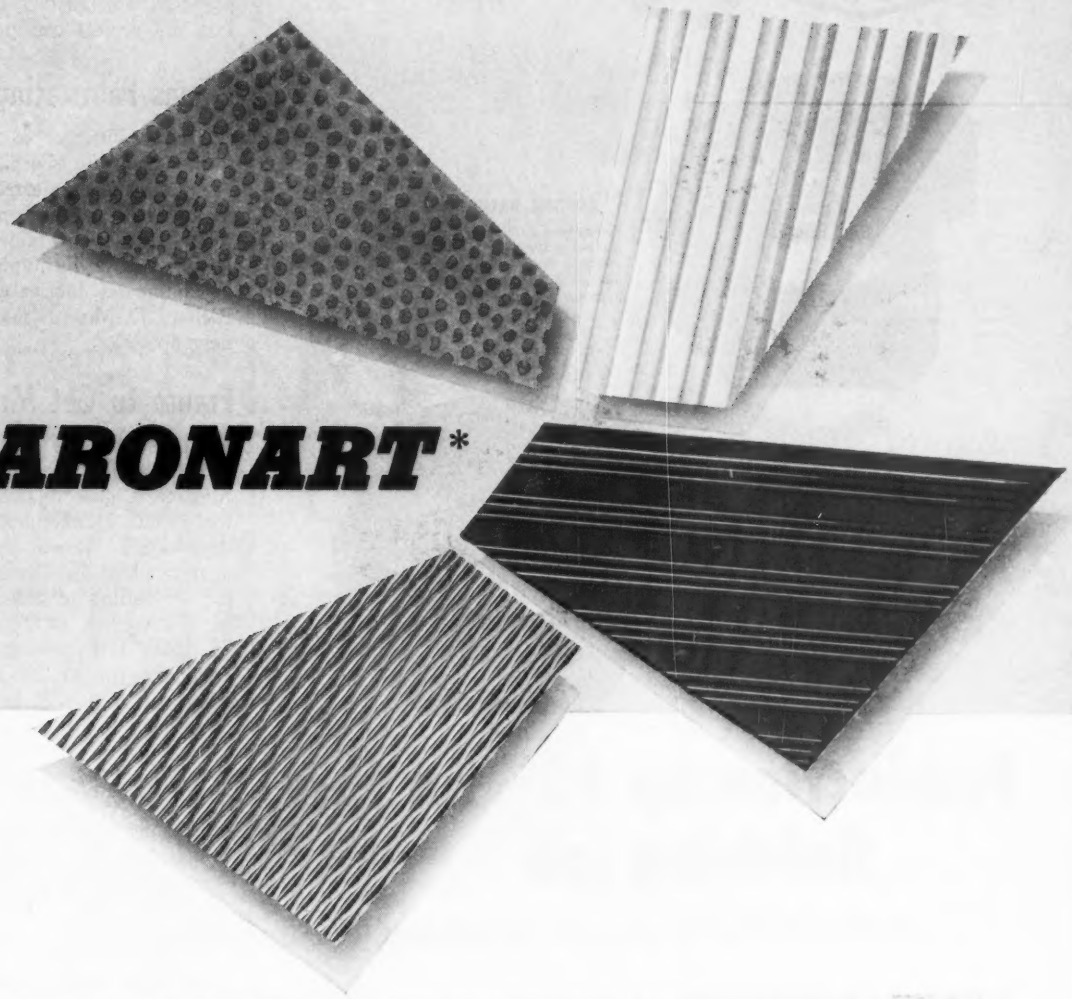


One of America's best known and most successful designers, Russel Wright, is practically a household word to Mrs. America. He, more than any other one man, has brought practical design to the average American housewife. Mr. Wright believes "good design" should be universal and his general aim is to create the widest variety of products for the widest possible market at the lowest possible cost so that "good design" can reach everyone.



Russel Wright designs with...





....SHARONART*

The portable broiler is high on the list of appliances most wanted by the modern American housewife. Until recently, little attention was paid to its design. The unwieldy bulk and lackluster styling of most models contrasted with the functional beauty of today's colorful kitchens and kitchen tools.

Russel Wright, world famed designer, has applied his talents to this appliance and has created a broiler with the attractive tailored look designed to harmonize with modern day kitchens.

In place of the outmoded polished chromium cover, Mr. Wright has utilized Sharon Steel's exciting new Sharonart* stainless in combination with a main shell of colored baked enamel over textured Sharonart*. Russel Wright has replaced impractical broiler operation with simple, functional, press-down levers that automatically set the thermostat and timer, and has included a stainless steel well-and-tree tray designed to be carried to the dining table and generous bakelite handles for safe carrying of the unit.

Whether you make broilers—or any other appliance—it's certain Sharonart* will give your product the same fresh look Russel Wright has achieved in this broiler design. *The Sharon Steel Corporation, Sharon, Pa.*

*T. M.

SHARONSTEEL **SHARON** *Quality* **STEEL**

OSBORN

BEFORE BRUSHING

Corners of intricate multiple contours were hand-filed to remove burrs. Results were inconsistent. Former production rate: **24** *per hour.*

AFTER BRUSHING

All surface junctures are blended accurately to predetermined specifications. Results are uniform...quality is high. Osborn 3-A Machine production rate: **63** *per hour.*

Production up 62% on this finishing job

...with OSBORN power brushing

PUSH-BUTTON FINISHING OPERATION . . . *with Osborn 3-A Machine using Osborn Economy® Wire Brushes. Operator simply loads part...starts pre-set brushing cycle... and unloads part after brushing.*

Formerly, this air conditioner manufacturer finished 24 compressor bodies per hour. He now finishes 63 per hour . . . *a 62% increase in production.* But that's just the start.

Quality now is uniform because Osborn power brushing thoroughly removes all burrs that might ultimately damage the compressor. Each surface juncture of the intricate contour is also formed to an exacting, predetermined blend . . . all automatically.

Your Osborn Brushing Analyst will gladly provide complete details. He will show how you can benefit on similar operations in your own plant.

Write now for full details on Osborn Metal Finishing Machines. *The Osborn Manufacturing Company, Department S-14, Cleveland 14, Ohio.*

Osborn Brushes

METAL FINISHING MACHINES...AND FINISHING METHODS
POWER, PAINT AND MAINTENANCE BRUSHES • FOUNDRY PRODUCTION MACHINERY

(*Concluded from Page* 123)

of a zoning change covering the proposed site must be obtained before the project can proceed.

Opens Fabricating Plant

Parker Fittings & Hose Div., Parker-Hannifin Corp., Cleveland, established an industrial hose assembly fabricating plant at 500 S. Wolf Rd., Des Plaines, Ill. The facility has new equipment devised for improved fabrication methods. Richard D. Moat is manager of the new operation.

France to Get Mesta Mill

Mesta Machine Co., Pittsburgh, is building a 45 in. x 120 in. slabbing mill and related equipment for Societe Dunkerquoise de Siderurgie, Paris. It will be installed in a new plant in Dunkirk, France, for the rolling of slabs 3 in. to 12 in. thick, 40 in. to 65 in. wide, and 75 in. to 118 in. long from ingots weighing up to 25 tons. Slabs from the mill will be rolled into plates.

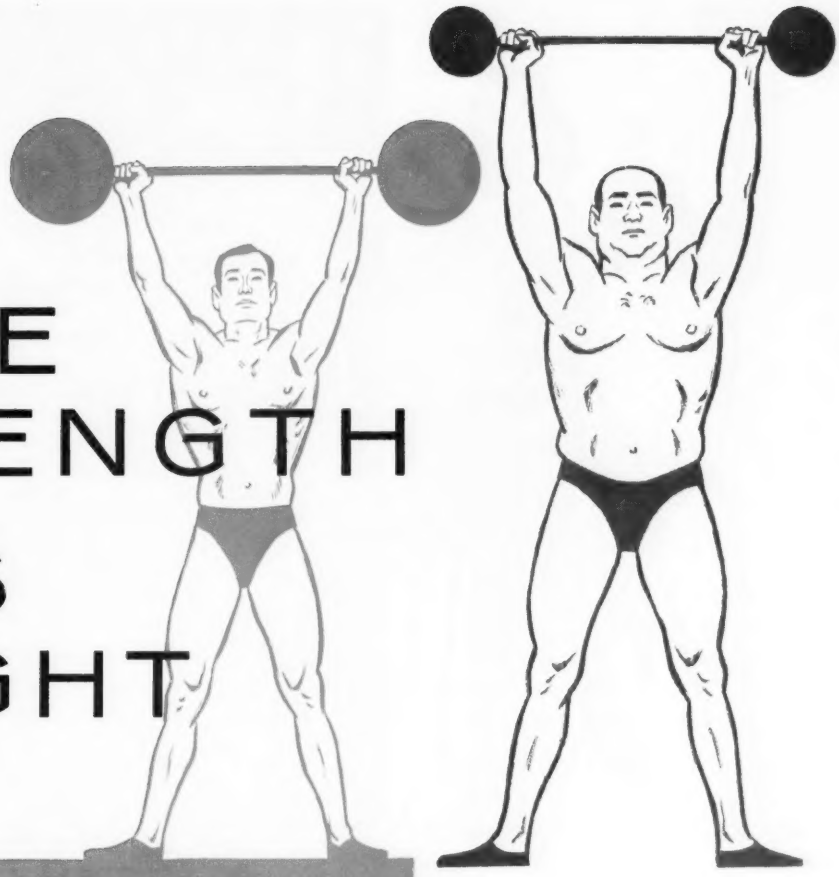
Dayton Firm Expanding

Simonds Worden White Co., Dayton, Ohio, has launched a program to double production capacity of its Grinding Wheel Div. The project will include construction of a 15,240 sq ft plant addition and installation of two car-bottom kilns, two 600 ton down acting hydraulic presses, a power stripper for large vitrified wheels, preheater for hot pressed resinoid wheels, and a continuous oven for curing resinoid wheels.

Forms Electronic Company

Controls Co. of America, Schiller Park, Ill., organized a subsidiary, Solid State Electronic Controls Inc., with plant and headquarters at Tempe, Ariz. The new firm will manufacture such items as silicon solar converters and other semiconductor devices. A 10,000 sq ft plant is being constructed. Dr. F. W. Schwarz will be president and general manager; Glenn W. Skouson, director of operations.

Milwaukee Valve Co., Milwaukee, a subsidiary of Controls Co. of America, sold its business and cer-



MORE STRENGTH LESS WEIGHT

specify
A. W. DYNALLOY

A. W. DYNALLOY Steel provides higher strength per unit of weight . . . lets you cut weight in fabricated products.

Specify DYNALLOY and realize these additional advantages: weldability, easy formability and resistance to corrosion and impact. In products where high strength and low weight are desirable, DYNALLOY will provide you with a means to higher quality production . . . lower costs . . . increased profits. Call your Alan Wood Representative today! He's always available and ready to help.

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DISTRICT OFFICES AND REPRESENTATIVES
Philadelphia • New York • Los Angeles • Atlanta • Boston • Buffalo • Cincinnati • Cleveland
Detroit • Houston • Pittsburgh • Richmond • St. Paul • San Francisco • Seattle
Montreal, Toronto and Vancouver, Canada—A. C. Leslie & Co., Limited

WANTED: more "wife savers"

UNILOY
STAINLESS STEELS

Modern homemakers know that dishwasher detergents cannot mar the gleaming beauty of household items made of stainless steel. That's why sales are soaring in new and growing markets for these attractive, enduring, easy-to-keep-clean "wife savers."

For uniform high quality, lustrous finish and ease of fabrication . . . always specify Uniloy Stainless Steel.

UNIVERSAL CYCLOPS
UC STEEL
STEEL CORPORATION
BRIDGEVILLE, PA.

STAINLESS STEELS • TOOL STEELS • HIGH TEMPERATURE METALS

tain assets to a group of Chicago investors. Officers of the new company, Milwaukee Valve Co. Inc., are: President, Herschel Seder; executive vice president, Max Koenigsberg.

Fabricates Precipitator

Baltimore shops of the Metal Products Div., Koppers Co. Inc., Pittsburgh, have completed fabrication of an electrostatic precipitator for U. S. Steel's new sinter plant at Tennessee Coal & Iron Div., Birmingham. The unit, designed to clean exhaust gases at the rate of 433,000 cfm, will be built by Koppers' Engineering & Construction Div. as part of that division's contract to construct the entire sinter plant.

Asarco Gets Concentrator

Western-Knapp Engineering Co., San Francisco, is designing a copper flotation concentrator for American Smelting & Refining Co., New York. The 15,000 ton per day unit is for Asarco's $40 million project near Tucson, Ariz. The mill is expected to annually process 5.4 million tons of material, yielding about 45,000 tons of copper. The project is scheduled for completion in about two and one-half years.

Electronics Firm Expands

Ling-Altec Electronics Inc., Anaheim, Calif., has launched a $600,000 expansion program. The enlarged facility will include one new manufacturing building and will provide about 65,000 sq ft of additional space. The company will move its Culver City, Calif., plant to the Orange County site which is the main plant of its subsidiary, Altec Companies Inc.

Bristol Invests in South

Bristol Steel & Iron Works Inc., Bristol, Va., purchased one-half of the common stock of E-Z-Go Car Corp., Augusta, Ga., manufacturer of electric golf carts and other electrical vehicles. New officers of the corporation are: President, B. F. Dolan; executive vice president, W. A. Dolan Jr.; vice president, W. J. Tilley; secretary, W. J. Tilley

(*Please turn to Page* 132)

Interstate Gets a Higher Quality Finish and Paint Mileage is More Than Doubled with

RANSBURG

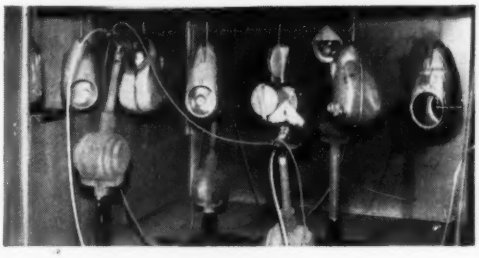
NO. 2 PROCESS ELECTROSTATIC SPRAY PAINTING

in finishing

COMPACT VACUUM CLEANERS

Interstate Engineering Corporation in Anaheim, Calif. switched from hand spray to Ransburg automatic Electro-Spray in the painting of their quality line of home renovating products: The COMPACT vacuum cleaner . . . the POLISH-AIRE floor polisher . . . and MAGIC DISC carpet and rug sweeper.

RESULTS? Quality of the painting improved, for with former hand spray, rejects used to run as high as 10%. That's because of Interstate's high quality standards. Now, with Electro-Spray, rejects are cut to less than 2%! This alone would have justified the change, but Ransburg Electro-Spray also provides substantial labor and material savings. One operator now does the work of two. And, with the former method, Interstate was painting only 28 sets of parts per gallon of paint. Now, they get 57 sets of parts per gallon. Think of what 50% savings would mean in YOUR finishing department.



Vacuum cleaner parts are painted with wrinkle enamel as they pass through the electrostatic spray painting area in the finishing department at Interstate Engineering Corp. Unpainted parts, entering from the right, are coated uniformly by the two Ransburg atomizing bells on either side of the line.

NO REASON WHY YOU CAN'T DO IT, TOO!

Let us show YOU and test-prove the advantages of automatic electrostatic spray painting on YOUR products in our complete laboratories. Call or write for our No. 2 Process brochure which shows a variety of automatic painting installations on a wide variety of products in both large and small plants. Or, if your production doesn't justify automatic painting, let us tell you about the new No. 2 Process Electrostatic Hand Gun which can be used in either conveyorized, or non-conveyorized painting.

RANSBURG

RANSBURG Electro-Coating Corp.

Box-23122, Indianapolis 23, Indiana

You'll enjoy production profits with HOUGHTON'S

"Metalworking Medley"

Quenching Oils
Coolants
Rust Preventives
Cleaners
Heat Treating Salts

. . . for complete control and "hi-fidelity" results, time after time.

Developed specifically for quenching only. For fast quenching, complete wetting-out, deep and uniform hardening and long life—Houghto-Quench can't be beat.

ALL SMASH HITS!

Hear them
at Booth 1406
National Metal Show
Chicago

. . . "the coolest yet" . . . stays mint-fresh for life.

New 100% Chemi-Cool Hocut 237 cools, lubricates, prevents rust, stays mint-fresh for life—has already proved itself one of the most versatile, effective and economical coolants in metalworking.

ALL TOP PERFORMERS!

. . . "set the tempo" for modern heat treating.

The precision quenching possible with Houghton Mar-Temp Salts prevents distortion and cracking, yet insures the strength and hardening accuracy necessary for precise performance and reliability.

. . . there's one to "harmonize" with your production processes.

A full line of cleaners to speed and simplify industrial metal cleaning of all types. Includes Houghto-Clean 313-A, a prefinish metal cleaner that cuts cleaning time and costs and eliminates need for special acid-resisting equipment.

. . . most famous names in rust prevention . . . "in tune with the times".

Featuring polarized Rust Veto 377—the economical, effective indoor rust preventive that protects whether metal is dry or wet—actually raises water off metal to form a long-lasting protective film under the moisture. Effective, without staining, on all types of metal for as long as a year.

Get the full story on these all-star performers plus many oldtime Houghton favorites. Also, get the new Salt Bath Handbook, ready at Metal Show time. Call or write E. F. Houghton & Co., 303 W. Lehigh Avenue, Philadelphia 33, Pa.

products of . . .

E. F. HOUGHTON & CO.

Ready to give you on-the-job service

Philadelphia • Chicago Carrollton, Ga. • Detroit • San Francisco • Toronto, Canada

for profitable short run production...

the **STRIPPIT FABRICATOR**

WORK PIECE – Electronic Chassis — 10" x 14" — 23 holes — 5 sizes — 4 different shapes — 4 corner notches

SETUP TIME – 9.3 minutes

PRODUCTION RUN – 5 pieces

PRODUCTION TIME PER PIECE – 2.8 minutes

For short or pilot runs—model shop and experimental work—no other single machine can match the production capabilities and profit potential of the Strippit Fabricator.

PUNCHES—any round or shaped hole up to 3½" diameter in sheet material — up to ¼" mild steel.

NOTCHES—90° corners — rectangular, radii, vee and special shape edge notches — up to ⅛" capacity in mild steel.

NIBBLES—straight line or contour shearing up to a 38" diameter circle, at 165 strokes per minute, ⅛" mild steel.

ACCURATE, QUICK-SET GAUGING—a unique, multiple-stop system permits exact positioning of the work to any layout specifications in seconds instead of minutes.

QUICK-CHANGE PUNCHES AND DIES—changed from one size to another in less than 20 seconds — within easy reach in labeled, built-in file drawers.

EASY CONVERSION—to a production punching unit by adding the Strippit Duplicator for high speed production of hundreds of pieces — and the Dupl-O-Scope to punch Duplicator templates from a drawing, layout or sample part.

WRITE TODAY—for Catalog 10 AA and an actual demonstration right at your own plant of the capabilities of this high-profit fabrication system, by a Strippit Mobile Demonstration Unit.

WALES STRIPPIT INC.

210 Buell Road • Akron, New York

A UNIT OF HOUDAILLE INDUSTRIES, INC.

In Canada: Strippit Tool & Machine Company, Brampton, Ontario

(*Concluded from Page* 129)

Jr.; and assistant treasurer and assistant secretary, William McGahee.

Eaton Unit to Expand

Shuler Axle Co., Louisville, will construct a 45,000 sq ft suburban assembly plant. The building and equipment will cost about $650,000 and will raise manufacturing capacity by about 25 per cent. Shuler is a subsidiary of Fuller Mfg. Co. Kalamazoo, Mich., which in turn is part of Eaton Mfg. Co., Cleveland.

Plans $12 Million Project

Olin Mathieson Chemical Corp., New York, has announced a two year expansion program for its Packaging Div., principally at the division's headquarters at West Monroe, La. The program calls for an investment of $12 mililon. A $30 million expansion in the company's Chemicals Div. was announced earlier.

NEW ADDRESSES

Jones & Laughlin Steel Corp., Pittsburgh, moved its Tulsa, Okla., sales office to Room 811, First National Bank Bldg., that city. J. A. Heineman is resident salesman; R. G. Carney, sales manager, St. Louis district.

Illinois Tool Works, Chicago, moved its two West Coast divisions, Pacsol and Calinoy, into a new plant at 3155 El Segundo Blvd., Hawthorne, Calif. N. Heath McDowell is directing the activities of the two divisions. Pacsol (formerly Pacific Solenoids Inc.) produces rotary solenoids and switching devices; Calinoy, special purpose metal and plastic fasteners.

ASSOCIATIONS

National Association of Sheet Metal Distributors, Philadelphia, elected these officers: President, A. B. Lewis, Palmer-Donavin Mfg. Co., Columbus, Ohio; and vice presidents, R. W. Mason, Marathon Equipment & Supply Ltd., Toronto, Ont., and Noel E. Girard, Girard

STEEL MILL CUTS REGRINDING TIME IN HALF WITH MIDVAC

Micro Lustre

VACUUM MELTED FINISHING ROLLS

A switch from air-melted rolls to MidVac Rolls reduced regrinding and refinishing time by as much as 50% in one large steel mill. Now, operators can refinish rolls quicker to a higher polish which produces finer sheets.

MidVac Rolls are made with consumable electrode vacuum melted MidVac Steels. These super-alloy steels produce a Micro-Lustre finish made possible by super uniformity of fine grain structure, maximum freedom of defects and non-metallic inclusions. MidVac Micro-Lustre Rolls assure rolling free from surface imperfections . . . quicker regrinding . . . and give longer trouble-free service between grinds.

MidVac Rolls are being used throughout the nation for rolling stainless steel, aluminum, foil, brass and precious metals. Midvale-Heppenstall also make forged rolls of any size, for any purpose required in the rolling of steel, aluminum, copper, brass and other metals . . . as well as paper, plastics and rubber. Write for complete data on these new Micro-Lustre Rolls.

MH

MidVac Rolls

MIDVALE-HEPPENSTALL CO., NICETOWN, PHILADELPHIA 40, PA.

Subsidiary of HEPPENSTALL COMPANY, Pittsburgh, Pa.

Universal Lubricating Systems, Inc.

OAKMONT, PA.

Their continuous use of

WYCKOFF

LEADED COLD DRAWN BARS

has definitely increased their production, extended tool life, and produced a better finish at higher machining speeds.

Why not check the possibilities of Wyckoff Leaded Steels on your requirements? They're available in AISI analyses – carbon and alloy steels.

SPECIALISTS IN COLD FINISHED STEELS EXCLUSIVELY

WYCKOFF STEEL COMPANY

GENERAL OFFICES:
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OUR CONSTANT RESEARCH PROGRAM IS YOUR BEST GUARANTEE OF QUALITY CONTROL

WYCKOFF STEEL PRODUCTS • Carbon, Alloy and Leaded Steels • Turned and Polished Shafting • Turned and Ground Shafting • Large Squares • Wide Flats up to 12¾" x 2¼" and 14" x 1¼" • All types of Furnace Treated Steels including Carbon Corrected Steels

Steel Supply Co., St. Paul. Thomas A. Fernley Jr. is executive secretary.

T. A. McMullen, Herbrand Div., Bingham-Herbrand Corp., Fremont, Ohio, was elected president of the **Service Tools Institute**, New York.

Wilfrid G. Matheson, Sylvania Electric Products Inc., New York, has been named president of the **American Vacuum Society**, Boston.

NEW PLANTS

Chrysler Corp., Detroit, plans to build a multimillion dollar plant for its New Process Gear Div. in De Witt (Syracuse), N. Y. The plant will cover 400,000 sq ft of floor area and will replace the three buildings now occupied in downtown Syracuse. The new plant will not affect operations at the plant on Wolf Street, Syracuse, or at the foundry and machine shop in Auburn, N. Y.

Peerless Gear & Machine Co. Inc. is operating in its new 25,000 sq ft plant at Dunkirk, Ohio. Office space accounts for an additional 2400 sq ft. The firm makes racks and pinions for the diecasting industry and speed reducers used by original equipment manufacturers in the industrial and farm machinery fields.

Union Carbide Corp., New York, will build a plant at Marietta, Ohio, to produce bisphenol-A (used in making epoxy resins and other phenol based plastics). The plant will be operated by a division, Union Carbide Plastics Co. Rated annual capacity: 25 million lb.

General Impact Extrusions Ltd. is constructing a plant on Evans Avenue, Etobicoke (Toronto), Ont. The company produces collapsible tubes, capacitor shields, and coil cans.

Gordon Duff Inc., Los Angeles, welding supply firm, has opened a branch plant at 18615 Parthenia St., Northridge, Calif. The facility will more than double the company's service output of compressed

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WESTERN UNION TELEGRAM

1211 (4-55)

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STEEL

oxygen for southern California industry.

CONSOLIDATIONS

Kawneer Co., Niles, Mich., acquired **South Bend Screw Products Inc.**, South Bend, Ind., manufacturer of precision machine parts for the aircraft, missile, automotive, and appliance industries. President of Kawneer's new subsidiary is D. G. Ehrich.

Cooper-Bessemer Corp., Mt. Vernon, Ohio, will purchase **Rotor Tool Co.**, Cleveland, subject to approval of stockholders. Rotor products include air powered grinders, buffers, nutsetters, impact wrenches, and chippers. Cooper-Bessemer products include compressors, heavy duty engines, and automatic control systems.

Dumore Co., Racine, Wis., purchased **Master Mfg. Co. Inc.**, Hutchinson, Kans., producer of machine tools. Dumore makes portable precision tools for milling, drilling, and grinding. Officers of the new subsidiary are: Chairman, Robert Hamilton; president, G. E. Shoup; vice presidents, Don Morton and Howard Anderson; secretary, M. E. Hamilton; and treasurer, M. H. Toland.

Dunkirk Radiator Corp., Dunkirk, N. Y., purchased **Marsh Valve Co.**, that city. Dunkirk Radiator makes cast iron boilers and radiators; Marsh, valves for the Navy and commercial users.

Porter-Cable Machine Co., Syracuse, N. Y., is negotiating for the purchase of **Rototiller Inc.**, Troy, N. Y. If the proposal is approved by Rototiller stockholders, the company will be operated as a subsidiary of Porter-Cable and will continue operations at the 45,000 sq ft plant in Troy.

R. D. Fageol Co., Kent, Ohio, purchased **B-Z Machine Products Co.**, that city, and will operate the property as a division. The new division will integrate machine work for all Fageol divisions in addition to handling contracts with other firms.

This New Door Guide Can Cut Costs at Every Opening!

Write today for this complete up-to-the-minute information on:

KINNEAR Steel Rolling Doors — with the coiling upward action of the famous interlocking-steel-slat curtain (originated by Kinnear). They save space, save time, provide all-metal protection.

KINNEAR Rolling Fire Doors — the exclusive, all-steel "Akbar" doors, famous for positive starting action, safe closing speed, other advanced features.

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KINNEAR Bifold Doors — Heavy-duty service doors of wood or all-steel. Center-hinged to fold upward with easy jack-knife action.

KINNEAR Rol-Top Doors — Sectional doors (wood or all-steel) available paneled for glass in any number of sections.

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GUTS

Mighty Mack Trucks... and the Morse cutting tools used to make them... are equally famous for *guts*. Mack on the road. Morse on the production line. Proof once again that to build the best you must build *with* the best.

Sound economics? Sure. Longer lasting more efficient tools *invariably* produce long-run economy.

Why not prove it to yourself. Your Morse-Franchised Distributor will gladly demonstrate to you the *practical* economics of buying the best in cutting tools... Morse, of course. *Call him in today.*

P.S. If you want to get the most out of the best twist drills made today, take a look at the Morse Production Drill Point Grinder. It *outpoints all other* machines. Write for new illustrated bulletin.

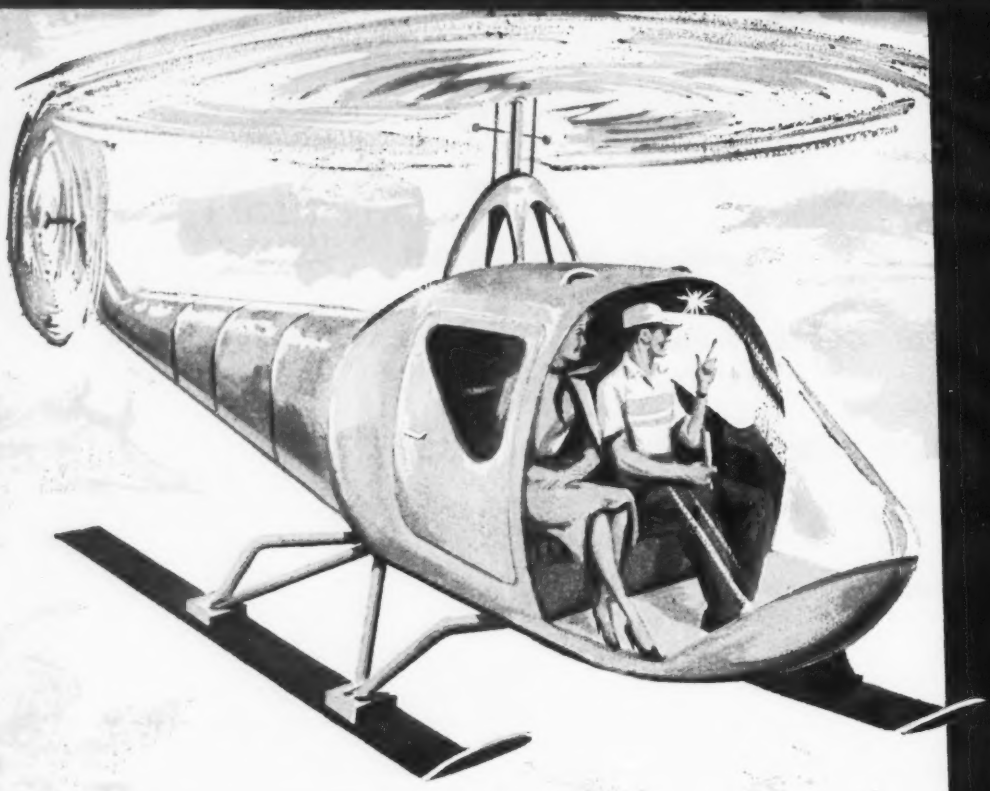
Morse CUTTING TOOLS

MORSE TWIST DRILL & MACHINE COMPANY
NEW BEDFORD, MASSACHUSETTS

WAREHOUSES IN NEW YORK, CHICAGO, DETROIT, DALLAS, SAN FRANCISCO

A Division of VAN NORMAN INDUSTRIES, INC. VN

MORSE *means* "THE MOST" *in Cutting Tools* 2215



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VALUABLE and VERSATILE!

Airborne jack-of-all-trades is the helicopter. Used for everything from mercy missions to eyes-in-the-sky reconnaissance, the extent of the whirlybird's versatility seems limited only by the imagination.

Calcium silicon and calcium manganese silicon offer similar versatility to steel producers. Dependable deoxidizers and degasifiers, these calcium alloys are widely used in production of bearing, aircraft quality and stainless steels. They also are extensively used in production of both alloy and carbon steel castings to assure maximum physical properties. Calcium silicon is an excellent inoculant for low carbon, equivalent-high tensile cast irons.

Ohio Ferro-Alloys is a major producer of both calcium silicon and calcium manganese silicon. Stocks of lump and crushed sizes for furnace and ladle additions are maintained at our conveniently-located plants and warehouses. For information on how these alloys may benefit you, contact our nearest sales office.

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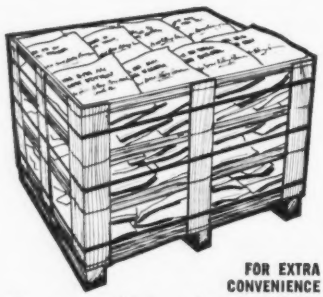
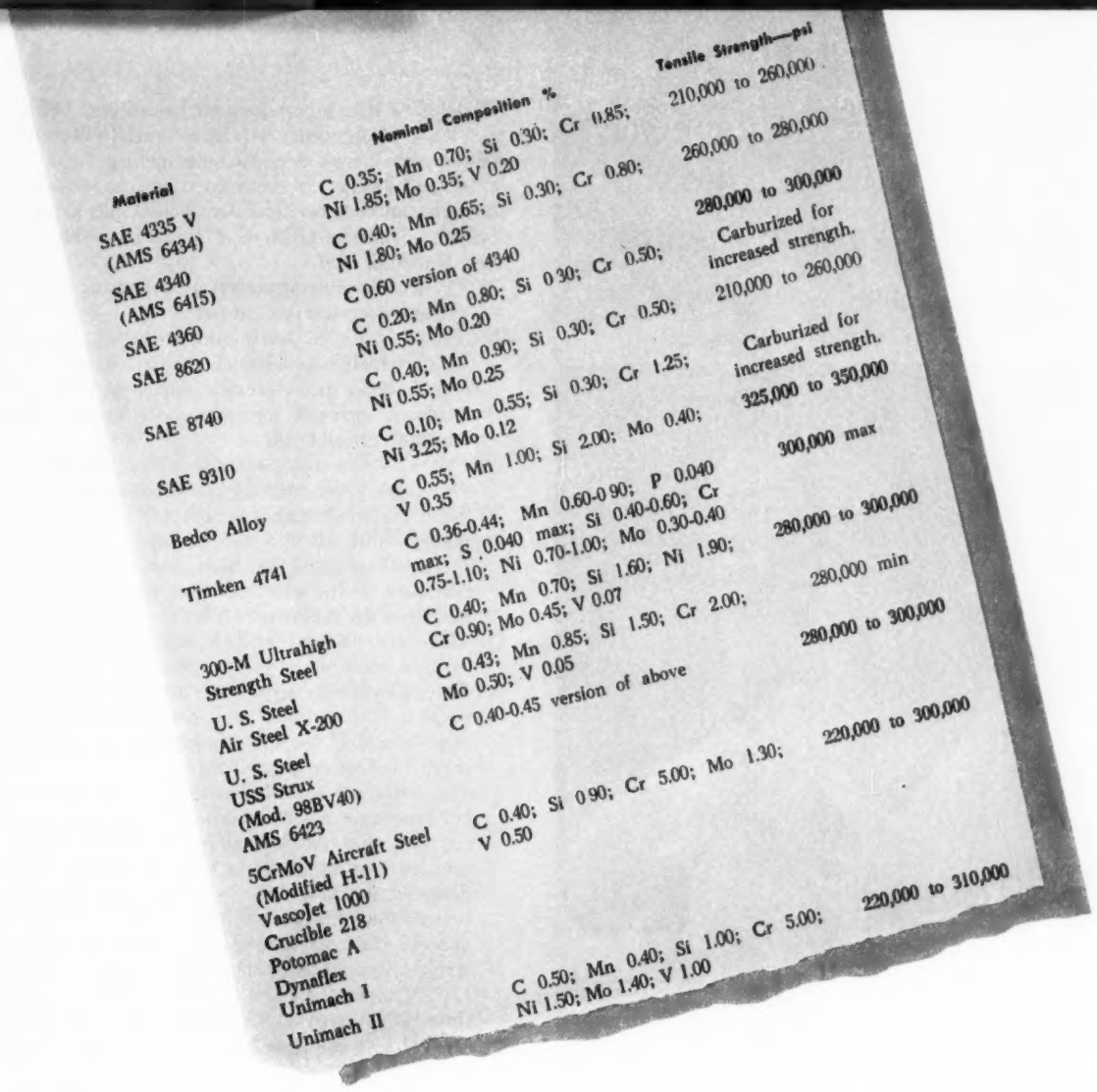


FOR EXTRA CONVENIENCE

Many users prefer to receive their calcium alloys in bags containing exactly 50 lbs. delivered in convenient-to-handle pallet crates holding approximately 1800 lbs.



Material	Nominal Composition %	Tensile Strength—psi
SAE 4335 V (AMS 6434)	C 0.35; Mn 0.70; Si 0.30; Cr 0.85; Ni 1.85; Mo 0.35; V 0.20	210,000 to 260,000
SAE 4340 (AMS 6415)	C 0.40; Mn 0.65; Si 0.30; Cr 0.80; Ni 1.80; Mo 0.25	260,000 to 280,000
SAE 4360	C 0.60 version of 4340	280,000 to 300,000
SAE 8620	C 0.20; Mn 0.80; Si 0.30; Cr 0.50; Ni 0.55; Mo 0.20	Carburized for increased strength. 210,000 to 260,000
SAE 8740	C 0.40; Mn 0.90; Si 0.30; Cr 0.50; Ni 0.55; Mo 0.25	Carburized for increased strength. 325,000 to 350,000
SAE 9310	C 0.10; Mn 0.55; Si 0.30; Cr 1.25; Ni 3.25; Mo 0.12	300,000 max
Bedco Alloy	C 0.55; Mn 1.00; Si 2.00; Mo 0.40; V 0.35	280,000 to 300,000
Timken 4741	C 0.36-0.44; Mn 0.60-0.90; P 0.040 max; S 0.040 max; Si 0.40-0.60; Cr 0.75-1.10; Ni 0.70-1.00; Mo 0.30-0.40	280,000 min
300-M Ultrahigh Strength Steel	C 0.40; Mn 0.70; Si 1.60; Ni 1.90; Cr 0.90; Mo 0.45; V 0.07	280,000 to 300,000
U. S. Steel Air Steel X-200	C 0.43; Mn 0.85; Si 1.50; Cr 2.00; Mo 0.50; V 0.05	
U. S. Steel USS Strux (Mod. 98BV40)	C 0.40-0.45 version of above	
AMS 6423	C 0.40; Si 0.90; Cr 5.00; Mo 1.30; V 0.50	220,000 to 300,000
5CrMoV Aircraft Steel (Modified H-11)		
VascoJet 1000		
Crucible 218		
Potomac A		
Dynaflex		
Unimach I		
Unimach II	C 0.50; Mn 0.40; Si 1.00; Cr 5.00; Ni 1.50; Mo 1.40; V 1.00	220,000 to 310,000

Are 1 Million psi Steels Possible?

"Yes," predict experts. They advise: Watch work on superalloys and refractory metals. Strongest material being produced now has tensile of 650,000 psi. Its shortcoming: Ductility. Until that problem is solved, its use is limited

TINY CRYSTALS of pure iron with tensile strengths up to 1.5 million psi may hold the key to alloys with strengths far beyond today's practical limit of 350,000 psi.

"Once we find the reason for such strength, we will have taken one more step toward getting similar values into practical shapes," predicts Dr. Victor F. Zackay, supervisor of physical metallurgy, engineering staff, Ford Motor Co., Dearborn, Mich.

In some limited applications, such as cutting tools, firms like Vanadium-Alloys Steel Co., Latrobe, Pa., claim they have attained 650,000 psi for some time. But such material has limited ductility.

Ford's success with 500,000 psi alloys in its scientific lab (STEEL, Sept. 21, p. 84) shows that better

The Metal Show Section

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Expert Predicts Role of Vacuum Methods

Dr. F. N. Darmara tells STEEL editors that he thinks vacuum methods will play an important part in getting more out of tomorrow's superstrength and high temperature steels

WHERE WILL superalloys go from here? What will their new applications be? How much will such materials cost? Where does vacuum melting fit in?

To get answers to those questions, STEEL asked an authority on vacuum induction melted alloys, Dr. F. N. Darmara, president, Metals Div., Kelsey-Hayes Co., New Hartford, N. Y.

Q: Dr. Darmara, can you tell us something about why we need such unusual alloys?

A: Temperatures in jet engine turbines require materials which take 1700° F at high stresses. Higher temperatures mean greater efficiency, so the trend is always upward, limited mainly by the development of better alloys.

Q: We all know that manned aircraft production is declining. Have superalloys been hurt?

A: To a certain extent, yes, but not as much as you would think. While production is declining, the increased amount of high temperature material necessary in the newer engines and aircraft frames has offset the decline.

Q: How are vacuum melted superalloys being used in missiles?

A: Superalloys are being used in certain nose cones, nozzles, fuel turbines, and other critical members.

Q: Are physical property requirements different in missile and space applications?

A: Yes. They are so different that I think that it may be some time before metallurgists get used to these concepts and develop alloys specifically suited to missiles. For example, jet engines and aircraft are designed for long life. They can also be reconditioned. But that's not true in most missiles. All our old concepts have been directed at developing stable alloys. Missile materials need to withstand high temperatures for much shorter lengths of time, so we need another approach to all materials.

Q: How do we compare with Russia in the technology of vacuum melting?

A: They are doing a tremendous amount of work in this field. Some of it is first-rate and imaginative. However, I don't believe they have anything to

ductility is possible. (It reports 9 per cent elongation.) Many believe that the Ford method (called Ausforming) will push us closer to the 1 million psi goal.

• Missile and aircraft needs spark the search. But civilian users will share in the benefits.

The improvements you can expect will stem from work in two closely related areas of metalworking research: Superalloys and refractory metals (which have good strength at high temperatures), and ultra-high-strength alloys (which excel in strength at comparatively average temperatures).

"Generally, high temperature work is turning toward the refractory metals, although service goals so far are only 50,000 psi at 2550° F for 10 hours," states Arthur F. Lytle, vice president of research, Union Carbide Metals Co., a division of Union Carbide Corp., New York. Everything from pure tungsten to columbium sheets are being fashioned for aircraft. (The first columbium sheets have already been rolled.)

Superalloys also have a lot to recommend them. Dr. F. N. Darmara, president, Metals Div., Kelsey-Hayes Co., New Hartford, N. Y., points to his firm's new family of alloys called Viscotherms. Containing little carbon, plus high chrome, nickel, and cobalt, they were derived from military formulas. In certain 2000° F plus environments in the glass industry, Viscotherm nozzles outlasted their stainless counterparts 100 times and still show no signs of wear.

John C. Hamaker Jr., director of research and metallurgical engineering, Vanadium-Alloys Steel Co., indicates that VascoJet 1000 is also finding its way into civilian uses. Rollshafts (which operate at high temperatures and high speeds) last much longer and reduce downtime greatly when made of the alloy. Its strength: Up to 310,000 psi at room temperature. Mr. Hamaker also points to applications in fastening devices for high pressure vessels, atomic installations, and transportation equipment. VascoJet springs

match our 5000 lb furnace. Unfortunately, there is a lack of communication, and we are not sure of anything they are doing. I feel strongly, though, that they are certainly capable of building large furnaces if they want to. This is especially true since their technical men seem to have unlimited funds at their disposal.

Q: Dr. Darmara, most production of vacuum melted superalloys at the present time goes into jet aircraft engines. What conventional applications do you foresee?

A: We all know that commercial airlines are using more jet and turboprop aircraft. They are powered by commercial versions of the military engines and hence make use of the same superalloys. Secondly, the commercial gas turbines, ranging from portable engines of 50 hp to mammoth stationary installations of thousands of horsepower, will utilize more and more superalloys as operating temperatures increase. There is also the automotive gas turbine.

Q: How far off is the automotive gas turbine engine?

A: This is difficult but my guess is four to five years.

Q: Is the nuclear power industry a market?

A: Yes, because of the extremely rigid specifications for most components.

Q: What about other industrial applications?

A: Vacuum induction melting is a metallurgical refining process which gives us the most precise control we know of. We feel these industries will benefit most from such materials: Electronics, nuclear power, processing, glass manufacturing, and those that use hot work dies.

Q: Has your new 5000 lb high vacuum furnace changed the industry's capacity picture?

A: It represents something like 20 per cent of present industry capacity, and it represents a design breakthrough for higher capacity furnaces of the high vacuum induction type. We can easily scale the design up to 10,000 lb.

Q: Will the price of superalloys ever be reduced?

A: Yes, definitely. Increased production rates will eventually permit some price reductions.

have shown 35 per cent more fatigue strength than any other material, he claims, pointing to numerous examples in steam turbines and internal combustion valves.

• The consensus is that progress hinges on two things: Refinement techniques like pressure melting and new combinations of alloying elements.

Mr. Lytle suggests a novel approach: High pressure melting. "It should be possible to suppress volatilization of low melting point metals so that metals like titanium, tungsten, or columbium which have high melting points can be treated with magnesium, calcium, and lithium which are unsurpassed deoxidizers. Alloys of such metals might be preserved at room temperatures," he concludes.

Another hope for high pressure melting is that some high temperature phases may be stabilized or that a fundamental rearrangement of crystal structure may be induced during solidification, bringing undreamed of properties.

J. W. Sands, supervisor, alloy steels, International Nickel Co. Inc., New York, says that the direction of development at his firm has been the further modification of 4340 compositions. "Our research has been directed away from working with steels of the H-11 types (hot die steels). We are modifying 4340 with rather large amounts of silicon. We have extended useful strength levels to 330,000 psi through a refrigeration treatment during the heating cycle. But we are working on adding other alloying elements to these new compositions to return to standard quench and temper treatments."

Vanadium-Alloys has an experimental material which develops 330,000 psi through heat treatment alone.

• The Ausforming idea is widely recognized for its ability to improve tensile strengths while retaining ductility. But few see how it can be commercialized.

Many of the experts interviewed by STEEL noted that Ausforming

How Expensive Superalloys Can Save

Stainless blowpipe tip (left) lasts only a week when plunged repeatedly into 2000° F glass. Viscotherm tip (right) lasts more than a year under same treatment

Stainless 310—$0.45/lb		Viscotherm—$10/lb	
Life	Annual Cost	Life	Annual Cost
One Week	$33.80	One Year	$13.00

techniques may soon achieve tensiles well above the 500,000 psi mentioned by Ford. (Some even suggest tensiles well over 600,000.) International Nickel is sponsoring research at Case Institute of Technology, Cleveland. Watertown Arsenal is also active in this area.

Main drawbacks to commercialization: Problems with mechanical reducing equipment and the forming of finished shapes. Rolling mills used for bars and shapes quickly lose bearings under the terrific pressures needed. Finished shapes often have hardnesses above Rockwell 65.

International Nickel is working in a direction away from the warm working idea used by Ford. It wants a steel which retains substantial amounts of metastable austenite at room temperatures rather than in the 800 to 1050° F area.

• New ideas and some breakthroughs are needed to solve the forming problems connected with superalloys and super-high-strength steels.

Some ideas are already appearing in the missile field. High strength cylinders which enclose solid propellents are being made by wrapping several thin sheets of almost unworkable metal onto mandrels and fastening them by brazing or tackwelding. Roll ring forging and roll forming methods are making such cylinders directly from solid billets.

Mr. Hamaker expects the greatest improvements in technology to come in three areas: Vacuum melting, more highly alloyed compositions, and improved design and manufacturing techniques.

Mr. Hamaker points out that vacuum melting improves the physical properties of VascoJet 1000 25 to 50 per cent.

The experts also emphasize the value of knowhow gained from experience. For example, designers and engineers have learned quickly that products have to be exceptionally free of notches and stress raisers to take full advantage of supersteels.

"Don't overlook explosive forming and shock extruding," adds Mr. Lytle. "Some metals, particularly tungsten, become malleable after the primary crystal structure is broken down. Explosive methods bring about plastic deformation in materials which ordinarily crack easily."

• Experience gained in superalloys and ultrahigh strength steels eventually results in the improvement of lower strength alloys.

Experience in missiles is already helping some firms. J. I. Case Co., Racine, Wis., uses superstrength steels for many of its transmission members. "Such steels are preferred because they offer the best properties in quenched and tempered properties," representatives state. "They harden uniformly even when section sizes vary."

Kelsey-Hayes's Viscotherm plan is aimed at the high temperature metal market in the glassmaking industry. But most producers are concentrating on military needs. However, they are open to questions and express willingness to co-operate in adapting their knowhow to civilian applications.

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STEEL
OCTOBER 26, 1959

Metal Selector

1959 EDITION

Edited for today's busy metalworking manager, this edition of the Metal Selector is the most comprehensive single source of information on metals and alloys available anywhere. In previous editions (the first was published in 1955), we covered standard metals one year, special metals the next. This year, the editors have combined them into one, easy-to-use booklet.

It is designed to help you pick the right material for your job.

- It covers 20 categories of ferrous and nonferrous metals, ranging from alloy steels to zirconium.
- In all, there are 1050 product listings.
- Compositions and applications are given to guide you in the selection of the material you need.
- Producers are named to help you find suppliers.
- A complete index to the metals and alloys in the Selector, arranged by categories, is on the inside front cover.

STEEL's Metal Selector is a continuing service for its readers.

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VACUUM MELTED METALS

Alloy or Trademark	Source—See Key	Nominal Composition %	Properties and Typical Uses
NICKEL-BASE ALLOYS			
Udimet 500 Unitemp 500 Hastelloy Alloy 500	2, 5, 8, 13 4* 3	C 0.10; Cr 19.00; Mo 4.00; Ti 3.00; Al 3.00; Co 19.00; Ni bal	Applications where high strength at high temperature is required. Jet engine and gas turbine buckets, discs, and bolts.
Udimet 600	5	C 0.10; Cr 18.00; Mo 4.00; Ti 3.00; Al 4.00; Co 18.00; B 0.40 max; Ni bal	High strength alloy for applications to 2000° F.
Udimet 700	5	C 0.15; Cr 17.00; Mo 4.00; Ti 4.00; Al 4.00; B 1.00 max; Co 18.00; Ni bal	Strongest wrought alloy available for applications from 1500-2000° F.
Inconel "713C" Alloy "713C" Alloy	21‡ 3‡, 5, 19, 22	Cr 12.00; Mo 4.50; Cb 2.00; Al 6.00; Ti 0.50; Ni bal	Jet engine blades.
Incoloy "901" Alloy "901" Alloy	21** 1**, 4*, 5, 6, 7**, 12**, 13, 14, 19	C 0.10 max; Cr 12.50; Ni 42.50; Mo 6.00; Ti 2.60; B 0.01-0.05	High stress rupture strength with excellent ductility at 1200° F, for jet engine wheels and rings.
J-1500	2, 19	C 0.15; Cr 20.00; Co 10.00; Mo 10.00; Ti 3.00; Al 1.00; Ni bal	Exceptionally high strength in 1000-1600° F range. Good ductility and forgeability; for turbine buckets and jet engine components.
J-1530	2, 19	C 0.08; Cr 19.50; Ni 57.00; Mo 4.30; Co 13.50; Al 1.30; Ti 3.10	Blades or high temperature parts for gas turbines.
J-1600	2, 19	C 0.10; Cr 19.00; Mo 4.00; Ti 3.00; Co 19.00; Al 3.00; Ni bal	High temperature areas in jet engines, gas turbines.
Superwaspaloy	1†, 2, 3, 4†, 5, 6, 8, 11†, 13, 14, 19	C 0.08; Cr 19.50; Ni 57.00; Mo 4.30; Co 13.50; Al 1.30; Ti 3.10; Fe 1.25 Zr 0.06; B 0.005	High stress rupture and endurance limit. Good ductility. Blades for turbojet engines.
Waspaloy	1*, 4†, 14	Same as Superwaspaloy, except 2.5Ti	Jet engine turbine and compressor wheels, spacers, etc.
GMR-235	1†, 2, 3‡, 4†, 5, 6, 8, 11†, 14, 19	C 0.15; Cr 16.00; Mo 5.30; Al 3.20; Ti 2.20; Fe 10.00; B 0.07; Ni bal	Good ductility and high rupture strength. Used in investment cast turbine blades, vanes, wheels.
GMR-235D	3‡, 4‡, 5, 8, 19	C 0.15; Cr 15.50; Mo 5.25; Al 3.60; Ti 2.50; Fe 4.25; B 0.07; Ni bal	Higher rupture strength than GMR-235. Used for same type of components.
Hastelloy Alloy R-235 Unitemp R-235	3 4*	C 0.16 max; Mn 1.00 max; Si 1.00 max; Al 2.00; Ti 2.50; Fe 10.00; Mo 5.50; Cr 15.50; Co 2.25 max; Ni bal	High temperature alloy for jet engine combustion cans, afterburners, blading, etc.
Hastelloy Alloy F	3	C 0.02 max; Mn 1.50; Si 1.00 max; Cb + Ta 1.75-2.50; Ta 0.50 min; Fe 15.00; Ni bal	Corrosion resistant to both acid and alkaline solutions. Used in sulfite pulp digesters for paper.
Hastelloy Alloy X	3, 4*	C 0.15; Cr 22.00; Mo 9.00; Fe 19.00; Ni bal	Flange rings in hot end of jet engines.
D-979	1**	C 0.01; Cr 14.00; NI 45.00; Mo 4.00; W 4.00; Ti 4.00; Al 1.00; B 0.01	Used in jet engines for stresses to 1600° F. Good workability.
AF 1753	4†, 6, 13	C 0.25; Cr 16.50; W 8.50; Mo 1.50; Co 7.50; Ti 3.15; Al 2.00; B 0.008; Zr 0.05; Fe 9.50; Ni bal	High temperature alloy with good hot workability.
Nicrotung	10	C 0.10; Cr 12.00; Cr 10.00; B 0.05; Zr 0.05; W 8.00; Al 4.00; Ti 4.00; Ni bal	Highly stressed parts at 1500-1800° F. Good room temperature tensile strength, ductility, castability and oxidation resistance for gas turbine nozzle vanes and buckets.
Rene 41	1*, 2, 3, 4†, 5, 6, 8, 11†, 13, 14, 19	C 0.09; Cr 19.00; Co 11.00; Mo 9.75; Ti 3.15; Al 1.50; B 0.005; Fe 2.50; Ni bal	Good oxidation and corrosion resistance; high strength at 1600-1800° F. One of the strongest materials that can be successfully formed and welded. Jet engine components.
Refractaloy 26	4*, 10**	C 0.03; Cr 18.00; Ni 38.00; Mo 3.20; Co 20.00; Ti 2.60; Al 0.20	Jet engine and gas turbine buckets, discs, bolts, etc.
K-42-B	4*, 10**	C 0.03; Cr 18.00; Ni 42.00; Co 22.00; Ti 2.10; Al 0.20; Fe bal	Jet engine and gas turbine buckets, discs, bolts, etc.
M-252	1*, 2, 3, 4* 5, 6, 8, 11*, 13, 14, 19	C 0.15; Cr 19.00; Ni 56.50; Mo 9.75; Co 10.00; Al 1.10; Ti 2.50; Fe 1.25; B 0.005	High stress rupture and endurance limit with better ductility than air melted alloys. Jet engine and gas turbine buckets, discs, bolts, and other hot area parts.
Viscotherm	5	Cr, Co, Al, Ti	Used in glass manufacturing. Especially suited for critical 900-1300° F operations for molds, plungers, conveyors, etc.
IRON-BASE ALLOYS			
A-286	1**, 4*, 5, 6, 7**, 9**, 11*, 12**, 13**, 14*, 15**, 17**, 18**, 19	C 0.06; Mn 1.50; Si 0.70; Cr 14.80; Ni 25.50; Mo 1.30; Ti 2.00; Fe 53.50; V 0.30; B 0.003; Al 0.20	High stress rupture and endurance limit; good transverse ductility. Wheels for turbojet engines, turbine case applications, afterburner nozzles, aircraft fasteners. Excellent hot workability of large cross sections.
AISI 51100	1*, 2, 4*, 5, 6, 7*, 9*, 11*, 12, 14*, 15**, 18**	C 1.00; Mn 0.35; P 0.025; S 0.025; Si 0.27; Cr 1.00; Fe bal	Bearing material. Low nonmetallic content, high fatigue strength, low frictional torque. Jet engine bearings.
AISI 52100	1*, 2, 4*, 5, 6, 7*, 9*, 10, 11*, 12**, 14*, 15**, 18**	C 1.00; Mn 0.35; P 0.025; S 0.025; Si 0.27; Cr 1.50; Fe bal	Bearing material. Properties similar to 51100 alloy.
Discaloy	1**, 4*, 5, 10, 12**, 13**, 17**, 18**	C 0.06; Mn 0.80; Cr 13.50; Ni 26.00; Mo 3.00; Ti 1.67; Fe 54.00; Al 0.20; B 0.007	High hot stress rupture and endurance limit; good ductility; wheels for turbojet engines.
W-545	10**, 12	C 0.08; Mn 1.50; Si 0.40; Cr 13.50; Ni 26.00; Mo 1.50; Ti 2.85; Al 0.20; B 0.08; Fe bal	High strength bar and forging material for use up to 1350° F. Large forgings, rings, and complex shafts; highly stressed parts in missiles and turbines; low temperature use in retaining rings and electrical apparatus.

(Continued on Page S-4)

VACUUM MELTED METALS (continued)

Alloy or Trademark	Source—See Key	Nominal Composition %	Properties and Typical Uses
D-6C D6AC	1°, 4°, 6°, 7°, 13°° 12°°, 15°°	C 0.46; Mn 0.75; Si 0.25; Cr 1.05; Ni 0.55; Mo 1.00; V 0.08 max	Ultrahigh strength steel; pressure vessels, structural parts, airframe components.
300-M	1°, 4°, 7°, 15°°	C 0.45; Mn 0.80; Si 1.60; Cr 0.80; Ni 1.80; Mo 0.40; V 0.07	Ultrahigh strength steel, pressure vessels, structural parts, airframe components.
M-308 (J-1300)	1°, 2, 4†, 5, 6, 11†, 13†, 14°, 17°°, 19	C 0.08 max; Cr 14.00; Ni 33.00; Mo 3.60-4.60; Al 0.25; Zr 0.25; W 6.50; Ti 2.00; B 0.004; Fe bal	Precipitation hardening bar and forging material for uses at temperatures up to 1350° F.
AMS 6427	1°, 15°°	C 0.30; Mn 0.90; Si 0.28; Cr 0.90; Ni 1.90; Mo 0.45; V 0.07	Superstrength structural parts, airframe components.
AMS 6434 (AISI 4335 + V)	1°, 7°	C 0.36; Mn 0.75; Si 0.50; Cr 0.80; Ni 1.80; Mo 0.35; V 0.20	Ultrahigh strength steel; pressure vessels.
Unitemp 212	4°†	C 0.08; Cr 16.00; Ni 25.00; Cb 0.50; Ti 4.00; Al 0.35; B 0.05; Zr 0.05; Fe bal	Jet engine parts.
V-57	1°, 6, 12°°, 13°°, 14, 15°°, 19	C 0.08 max; Mn 0.25 max; Si 0.56; Cr 14.75; Ni 25.50; Mo 1.25; Ti 3.00; Al 0.25; B 0.0075; V 0.30; Fe bal	High stress rupture and endurance limit; good transverse ductility. Wheels for turbojet engines, turbine cases, afterburner nozzles, aircraft fasteners.
HS 220 (AMS 6407)	15°°, 18°°	C 0.30; Mn 0.70; Si 0.60; Ni 2.05; Cr 1.20; Mo 0.45	Ultrastrength steel for aircraft uses; tensile strength to 240,000 psi.
HS 260	15°°, 18°°	C 0.40; Mn 0.70; Si 0.60; Cr 1.20; Ni 2.05; Mo 0.45	Ultrastrength steel for aircraft uses; tensile strength to 280,000 psi.
SAE 4340 AISI 4340	1°, 2, 4°, 5, 6, 7°, 9°, 10, 11°, 12°°, 13°°, 14, 15°°, 18°°	C 0.40; Mn 0.70; P 0.04; S 0.04; Si 0.30; Ni 1.80; Cr 0.80; Mo 0.25; Fe bal	Superstrength structural parts, airframe components, high strength gears.
Crucible 56	6	C 0.40; Mn 0.55; Si 1.00; Cr 3.25; Mo 2.50; V 0.33	Ultrahigh strength material for use up to 1100° F.
5CrMoV Aircraft Steel VascoJet 1000 Pyromet 882 Crucible 218 Potomac A Dynaflex Unimach #1	(Mod. H-11) 7° 14° 6 1° 9° 4°	C 0.40; Cr 5.00; Si 0.90; Mo 1.30; V 0.50; Fe bal	Ultrahigh strength material for use up to 1000° F.
HWD #2	13°°	C 0.37; Cr 5.25; Mo 1.30; Si 1.00; V 0.50	Ultrahigh strength material; tensile strength to 290,000 psi.
Unimach #2	4°	C 0.50; Si 1.00; Cr 5.00; Mo 1.40; V 1.00; Ni 1.50	Structural steel for high temperature service.
AISI 6150 SAE 6150	1°, 2, 4°, 5, 6, 7°, 9°, 11°, 12°°, 14, 15°°, 18°°	C 0.52; Mn 0.80; Si 0.30; Cr 0.95; Fe 97.50; V 0.21	High endurance limit, low nonmetallic inclusions. Aircraft valve springs, fasteners.
AMS-6260E AISI 9310 SAE 9310	2, 4°, 5, 6, 7°, 9°, 11°, 12°°, 13°°, 14, 15°°, 18°°	C 0.10; Ni 3.20; Cr 1.20; Mn 0.55; Si 0.25; Mo 0.12	Gear alloy, for critical aircraft gears.
AMS 6264C SAE 9317	4°, 5, 7°, 9°, 12°°, 15°°, 18°°	C 0.16; Ni 3.25; Cr 1.20; Mn 0.55; Mo 0.12	High strength steel.

ALLOY TOOL STEELS

AISI A-2 Air Hard	1°, 4, 6, 9°, 11°, 18°° 7°	C 1.00; Mn 0.60; Si 0.20; Cr 5.25; Mo 1.10; Fe 91.50; V 0.25	High temperature alloy for gages and rolls.
AISI D-2 Vacumeltrol 610 Ohio Die Ferrovac	1°, 2, 4°, 5, 9°, 11°, 12°°, 13°° 14 7° 6	C 1.50; Si 0.30; Mn 0.30; Cr 12.00; V 0.90; Mo 0.80; Fe bal	Nondeforming, cold work, die steel suitable for gages, thread rolling dies, drawing dies, coining dies, and rolls.
AISI D-4	1°, 2, 5, 6, 7°°, 12°°	C 2.20; Cr 12.00; Mo 1.00	Similar to D-2 but with greater wear resistance.
AISI H-11 Thermold A Extrad Hotform "V" HWD #2	2, 5, 9°, 11°, 14, 15°°, 18°° 4° 12°° 7°° 13°°	C 0.35; Mn 0.30; Si 0.90; Cr 5.00; Mo 1.30; V 0.50	Hot work die steel for thread rolling dies, gages, rolls. Superstrength structural parts, airframe components.
AISI H-13 (VDC) Potomac M	9°, 13°° 1°, 18°°	C 0.40; Si 1.00; Mn 0.30; Cr 5.25; Mo 1.25; V 1.00	High strength steel for aircraft structural applications.
AISI M-1	1°, 2, 4°, 5, 6, 7°, 9°, 11°, 12°°, 13°°, 14, 18°°	C 0.78; Mn 0.30; Si 0.30; V 1.15; Cr 3.75; Mo 8.55; Fe 83.50; W 1.60	Tool steel for high temperature bearings.
AISI M-2	1°, 2, 4°, 5, 6, 7°, 9°, 11°, 12°°, 13°°, 14, 18°°	C 0.83; W 6.00; Cr 4.00; V 2.00; Mo 5.00; Fe bal	High speed steel suitable for high temperature bearings, taps, drills, chasers, broaches, milling cutters, etc.
AISI M-10	1°, 2, 4, 5, 6, 7°, 9°, 11°, 12°°, 13°°, 14, 18°°	C 0.87; Mn 0.30; Si 0.30; Cr 4.00; Mn 7.90; Fe 84.50; V 2.00	High speed steel suitable for high temperature bearings, taps, drills, chasers, broaches, milling cutters, etc.
HTB-1 MHT	1°, 6, 7°, 14, 18°°	C 1.03; Mn 0.35; Cr 1.45; Al 1.00	High temperature bearings for jet engines.
AISI M-50 (HTB-2) BHT	1°, 2, 5, 6, 7°, 9°, 11°, 12°°, 13°°, 14, 18°° 4°	C 0.80; Mn 0.30; Si 0.20; Mo 4.25; V 1.00; Cr 4.00; Fe bal	Bearings, hot work die steel.
HTB-3 Halmo Virgo	1° 2, 6, 9°, 11°, 18°° 4°	C 0.57; Mn 0.30; Si 1.15; Cr 4.75; Mo 5.25; V 0.55	Jet engine and other high temperature applications.
AISI T-1	1°, 4, 5, 6, 7°, 9°, 11°, 12°°, 13°°, 14	Cr 4.00; W 18.00; V 1.10; C 0.75; Fe bal	Tool steel for high temperature bearings.
AISI T-15	1, 2, 4°, 5, 7°, 13°°	C 1.50; W 13.00; Cr 4.20; V 5.00; Cr 5.00; Fe bal	High speed steel with good wear resistance. Used for high temperature bearings, cutting and forming tools.
Rex Super Cut	6	C 0.80; Cr 4.00; V 2.00; W 18.50; Mo 0.60; Co 8.00	Tool steel for high temperature bearings.
Teton	1°	C 1.00; Cr 1.50	High compressive strength and abrasion resistance; ball and roller bearings, spindles and arbors.

Alloy or Trademark	Source—See Key	Nominal Composition %	Properties and Typical Uses
COBALT-BASE ALLOYS			
J-1570	1*, 2, 3, 4*, 6, 19	C 0.20; Cr 20.00; Ni 28.00; Co 37.50; Ti 4.30; Fe 1.40; W 6.00	Blades or high temperature parts for gas turbines.
J-1650	2, 19	C 0.20; B 0.02; Ni 27.00; Cr 19.00; Ta 2.00; W 12.00; Ti 3.80; Co bal	One of strongest wrought alloys commercially available.
Haynes Stellite Alloy No. 31 (X-40)	2, 3, 5, 8	Ni 10.00; Fe 1.00 max; Cr 23.00; W 7.00	High temperature areas in jet engines.
Altemp S-816 (AMS 5765A)	1, 4, 5, 6, 11, 14	Co 43.00; Cr 20.00; Ni 20.00; Mn 1.50; Mo 4.00; W 4.00; Cb + Ta 4.00; C 0.38	High temperature alloy.
HIGH TEMPERATURE ALLOYS			
AISI 304	1*, 15**	C 0.08 max; Mn 2.00 max; Cr 18.50; Ni 9.5	High temperature service, corrosive conditions.
AISI 305	1*, 15**	C 0.12 max; Mn 2.00 max; Cr 18.00; Ni 11.5	High temperature service, corrosive conditions.
AISI 310	1*, 4*, 5, 6, 8, 12**, 14, 15**, 18**	C 0.25 max; Cr 25.00; Ni 20.50; Fe bal	High temperature service under corrosive conditions.
AISI 316	1*, 4*, 5, 6, 7*, 14, 15**, 18**	C 0.08; Cr 17.00; Ni 12.00; Mo 2.50	High resistance to corrosives affecting other stainless steels; high creep resistance.
AISI 316L	1*, 4*, 5, 6, 7*, 12, 15**	C 0.03 max; Cr 17.00; Ni 12.00; Mo 2.50	Resistant to intergranular corrosion after welding or stress relieving.
AISI 347	1*, 2, 4*, 5, 6, 11*, 12**, 14, 15**, 18**	C 0.08; Mn 1.90; Cr 18.00; Ni 9.90; Cb + Ta 0.90; Fe bal	Crack-free core wire for welding and miscellaneous uses. Jet engine parts in cyclical heat zone.
AISI 403	1*, 4*, 5, 6, 7*, 9*, 12, 14, 15**	C 0.15 max; Cr 12.20; Si 0.50 max; Mn 1.00 max	Steam and gas turbine parts.
AISI 410 (AMS 5350C)	1*, 4*, 5, 6, 7*, 8, 9*, 12**, 14, 15**, 18**	C 0.15 max; Mn 1.00 max; Si 1.00 max; Cr 11.50-13.50; Ni 0.50 max; Fe bal	General purpose corrosion and heat resisting chromium steel.
Turbine Alloy (Type 422) Carpenter 636 Unitemp 1420WM	1*, 6, 7*, 9*, 12**, 15** 14 4*	C 0.20; W 1.00; Cr 13.00; Mo 1.00; Ni 0.75; V 0.40; Fe bal	Hardenable chromium steel; corrosion resistant.
AISI 430	1*, 7*, 9*	C 0.12 max; Mn 1.00 max; Si 1.00 max; Cr 16.00	Oil burner rings.
AISI 431	1*, 4*, 5, 6, 7*, 12**, 14, 15**	C 0.20 max; Cr 16.00; Ni 1.80	For heat treatment to high mechanical properties. Corrosion resistant.
AISI 440B	1*, 4*, 5, 6, 7*, 13*, 15**, 18**	C 0.85; Cr 17.00; Mn 0.50	Hardenable chromium steel; corrosion resistant.
AISI 440C	1*, 2, 4*, 5, 6, 7*, 9*, 11*, 13*, 14, 15**, 18**	C 1.05; Mn 0.375; Si 0.375; Cr 17.25; Mo 0.50; Fe 80.50	Stainless instrument bearings. Fine finish and high strength rolls.
AISI 440C Modified	7*, 9*	C 1.05; Mn 0.60; Si 0.35 max; Cr 14.00; Mo 4.00	Instrument bearings, high strength rolls.
Greek Ascoloy Unitemp 1415NW 418 Special	7*, 9*, 13*, 14, 15**, 18** 4* 1*	C 0.18; Cr 13.00; W 3.00; Ni 2.00; Fe bal	Heat resisting steel for jet engine compressor blades, turbine discs and auxiliary parts.
Unitemp N-155	1*, 4*, 13**, 14	C 0.15; Cr 21.00; Ni 20.00; Co 20.00; Mo 3.00; W 2.50; Cb + Ta 1.00; N 0.13; Fe bal	High strength to 1500° F; oxidation resistant to 1800° F. Jet engine tail pipes and afterburners, combustion chambers, nozzle assemblies, bolts, buckets, discs.
AM 350	1*, 4*	C 0.09; Mn 0.75; Si 0.35; Cr 16.65; Ni 4.50; Mo 2.85; N 0.10; Fe bal	Hardenable stainless grade. High strength corrosion and heat resisting.
AM 355	1**, 4*	C 0.13; Mn 0.75; Si 0.35; Cr 15.50; Ni 4.50; Mo 2.85; N 0.10; Fe bal	Similar to Unitemp 350.
Armco 17-4 PH	8, 12**	C 0.07 max; Mn 1.00; Si 1.00; Cr 16.50; Ni 4.00; Mo 0.50 max; P 0.04 max; S 0.03 max; Cu 4.00; Cb 0.35; Fe bal	Castings for high strength, corrosion and heat resistance.
Lapelloy Unitemp 1430MV	1**, 9*, 12, 14, 15**, 18** 4*	C 0.30; Cr 11.50; Mo 2.75; Ni 0.35; V 0.25; Fe bal	Gas turbine compressor discs and parts. Flange rings.
Lapelloy "C"	12, 14	C 0.20; Mn 0.65-1.00; Si 0.50 max; Cr 11.00-12.00; Ni 0.50 max; Mo 2.50-3.00; P 0.03 max; S 0.03 max; Cu 1.75-2.25; N 0.06-0.10	Similar to Lapelloy but with greater ductility and impact strength.
Carpenter H-46	14	C 0.15; Mn 0.57; Si 0.40; Cr 11.50; Mo 0.45; Cb 0.25; V 0.30; Fe bal	Outstanding resistance to stress corrosion cracking and oxidation. Steam and gas turbine buckets, compressor blades, discs, and bolts.
Carpenter 404	14	C 0.05; Mn 1.00; Si 0.50; Cr 11.00-12.50; Ni 1.25-2.00; N 0.03 max	Highly stressed parts at temperatures up to 1050° F where joining is a problem.
Inductovac MCS	4*	C 0.70; Si 1.05; Cr 3.50; Mo 5.50	High temperature bearings.
TBS-600	18**	C 0.95-1.10; Mn 0.60-0.80; P 0.025 max; S 0.025 max; Si 0.85-1.20; Cr 1.25-1.65; Mo 0.25-0.35	Bearing steel for high hardness and wear resistance to 600° F.
CBS-600	18**	C 0.16-0.22; Mn 0.50-0.70; P 0.040 max; S 0.040 max; Si 0.90-1.25; Cr 1.25-1.65; Mo 0.90-1.10	Bearing steel for high hardness and wear resistance to 600° F.
Inductovac 18-8B Ferrovac 304 B	4 6	C 0.06; Cr 19.00; Ni 9.50; Fe 69.00; B 2.15	Atomic energy applications, such as neutron control rods.
Inductovac 18-15B	4	C 0.01; Mn 1.20; Cr 18.00; Ni 15.00; Fe 65.00; B 0.80	Atomic energy applications, such as neutron control rods.
19-9 DL	1*, 4*, 12, 14, 15**	C 0.32; Cr 18.50; Ni 9.00; Mo 1.40; W 1.35; Cb + Ta 0.40; Ti 0.25	High temperature use in jet engine, gas turbine and turbosuperchargers as rotors, buckets, bolts, manifolds, tail cones.
19-9 DX	1*, 4*, 12, 14, 15**	C 0.32; Cr 18.50; Ni 9.00; Mo 1.60; W 1.35; Ti 0.55	Cb-free alloy. Same as 19-9 DL.
VSM	14	C 0.70; Mn 0.50; Si 1.10; Cr 3.00; Mo 5.25	High hot hardness, resistant to wear and abrasion at elevated temperatures. Used for valve seat inserts and stems, slides, guides, spindles, bearings.

(Continued on Page S-6)

VACUUM MELTED METALS (continued)

Alloy or Trademark	Source—See Key	Nominal Composition %	Properties and Typical Uses
AMS-5382B PWA-651	8	C 0.35-0.45; Mn 2.00-3.00; Si 1.00 max; Cr 25.50; Mo 2.00-4.00; Fe 5.00 max; W 7.50; S 0.03 max; Ni 10.50; Co bal	Castings for high temperature aircraft service.
Silmo-Vac	7*	C 0.58; Mo 5.00; Cr 4.75; Mn 0.30; V 0.55; S 1.10; Fe bal	High temperature bearings.

MISCELLANEOUS ALLOYS

Magnetic Alloy	8, 10	C 0.75; W 5.00; Si 0.20-0.35; Cr 4.00; Co 0.39; Fe bal	Castings and wrought forms for magnetic applications.
Polar	19	Modified 1020 steel	Magnetron pole pieces and special applications requiring vacuumtight seal.
Alnico	2, 19	Co, Ni, Al, Fe	Permanent magnets for high energy, high quality applications.
Core Iron	14	C 0.06 max; Mn 0.20 max; Si 0.25 max; V 0.10 max; Fe bal	For direct current magnetic applications in solenoids, armatures, and assemblies subject to high vacuum. Free from magnetic aging.
Kovar Nicoseal	10, 23 14	Co 17.00; Ni 29.00; Fe 54.00	Glass sealing alloy.
Thermenol	1, 4, 6	C 0.03; Mo 3.30; Al 15.40; Fe 81.27	Magnetic and heat resistant uses.
Alfenol	4, 6, 14	C 0.01; Al 15.85; Fe 84.00	Magnetic and heat resistant uses.
HyMu "800"	14	C 0.05; Mn 0.50; Si 0.15; Ni 79.00; Mo 4.00; Fe bal	For transformer cores, tape wound toroids and laminations where compactness and weight factors are important.
Cuprovac E	2, 6	99.98+ per cent copper	High purity, low gas content; low nonmetallics, low high-vapor pressure elements. Vacuum tubes, transmitting tubes, magnetrons.
Nivac P	2, 6	99.92+ per cent nickel	Properties similar to above. Vacuum tubes, hydrogen thyratrons, magnetrons, etc.
Ferrovac E	2, 6	99.92+ per cent iron	Properties similar to above. Magnetic alloys, vacuum tubes, magnetrons, klystrons, etc.
Ferrovac 49-2V Supermendur	6 10	Co 49.00; Fe 49.00; V 2.00	High saturation, high permeability magnetic alloy.
Ferrovac 50% Ni Hipernik	6 10	Ni 50.00; Fe 50.00	High permeability, low coercive force magnetic alloy.
Ferrovac 42% Ni	6	Ni 42.00; Fe 58.00	High permeability, low coercive force magnetic alloy.
Ferrovac Type 304	6	C 0.08 max; Mn 2.00 max; Si 1.00 max; Ni 8.00-12.00; Cr 18.00-20.00	Electronic tubes.
Rodar Therlo	16 20	Ni 29.00; Co 17.00; Mn 0.30; Fe bal	Metal to glass sealing alloy.
Cathode Nickel	16, 20	Ni 99.00 (+ Co) min	Vacuum tube alloy.
32 Alloy	16	Cu 98.50 min; Ni 1.00; P 0.20	High conductivity, high strength alloy for vacuum tubes.
Karma	20	Ni 75.00; Cr 20.00 + Al, Fe	Fine resistance wire.
#240 Alloy	20	Ni 80.00; Cr 20.00	High purity resistance wire.
#70 Alloy	20	Ni 60.00; Cr 15.00; Fe bal	High purity resistance wire.
Molybdenum	4**	1. Pure 2. Mo + Ti 0.50	Jet engine parts.

KEY TO SOURCE:

(1) Allegheny Ludlum Steel Corp., Pittsburgh.
(2) Metallurgical Products Dept., General Electric Co., Detroit.
(3) Haynes Stellite Co., division of Union Carbide Corp., Kokomo, Ind.
(4) Universal-Cyclops Steel Corp., Bridgeville, Pa.
(5) Metals Div., Kelsey-Hayes Co., New Hartford, N. Y.
(6) Crucible Steel Co. of America, Pittsburgh.
(7) Vanadium-Alloys Steel Co., Latrobe, Pa.
(8) Cannon-Muskegon Inc., Muskegon, Mich.
(9) Latrobe Steel Co., Latrobe, Pa.
(10) Westinghouse Electric Corp., Blairsville, Pa.
(11) Johnston & Funk Metallurgical Corp., Wooster, Ohio.
(12) Midvale-Heppenstall Co., Philadelphia.
(13) Firth Sterling Inc., Pittsburgh.
(14) Carpenter Steel Co., Reading, Pa.
(15) Republic Steel Corp., Cleveland.
(16) Wilbur B. Driver Co., Newark, N. J.
(17) Oregon Metallurgical Corp., Albany, Oreg.
(18) Timken Roller Bearing Co., Canton, Ohio.
(19) Allvac Metals Co., Monroe, N. C.
(20) Driver-Harris Co., Harrison, N. J.
(21) Huntington Alloy Products Div., International Nickel Co. Inc., New York.
(22) Thompson Ramo Wooldridge Inc., Cleveland.
(23) Refractories Div., Carborundum Co., Latrobe, Pa.

*All alloys are induction vacuum melted unless source is marked with asterisk, which indicates a consumable electrode melted grade is also available.

**Indicates only consumable electrode melted grade is available.

†Research indicates that combination induction vacuum, consumable vacuum may be advisable for improved hot workability.

‡Indicates these alloys are made as cast products only.

PRODUCERS' NOTES:

1. All Firth Sterling induction vacuum melted materials are prefixed by the word "Stervac," and all consumable electrode melted materials are prefixed by "Stercon" and "Stercon H" (Hopkins process).
2. Driver-Harris Co. is a custom melter and will produce special alloys to customers' specifications.
3. Allvac Metals Co. also melts the AISI alloy steels, the low alloy steels for missile applications, and materials for nuclear uses.
4. Republic Steel Corp. will vacuum melt any standard AISI grade steel and titanium.
5. Johnston & Funk Metallurgical Corp. will produce evaluation lots of a variety of vacuum melted materials.
6. Oregon Metallurgical Corp. is also a source for vacuum melted commercially pure titanium, the 6Al-4V titanium alloy, reactor grade zirconium, Zircaloy II, Zircaloy III, tungsten base alloys, molybdenum base alloys, columbium base alloys, and vanadium metal. All materials are available only in the consumable electrode vacuum melted grade.
7. Vanadium-Alloys Steel Co. induction vacuum melted materials are suffixed by "IVM." Consumable vacuum melted materials are suffixed by "CVM."
8. Allegheny Ludlum Steel Corp. produces a comprehensive list of alloys in high temperature, stainless, tool steel, and specialty grades. The company also vacuum melts zirconium, molybdenum, and similar metals.
9. Crucible Steel Co. of America has complete vacuum melting facilities for induction (VIM), arc remelt (VAR), and double melting (VIR). Any metal or alloy listed herein or others by special request will be considered for melting by any vacuum process.

HIGH TEMPERATURE ALLOYS

TYPE: FERRITIC LOW ALLOYS AND STAINLESS ALLOYS

Alloy	Composition %	Properties and Applications
Crucible 422	C 0.22; Mn 0.65; Si 0.36; Cr 12.00; Ni 0.70; Mo 1.00; W 1.00; V 0.25; Fe bal	Alloys are higher strength modifications of AISI standard 12% chromium, Type 403 stainless. Various grades are used for steam and gas turbine buckets, compressor blades, discs, and bolts. Outstanding resistance to stress-corrosion cracking and oxidation. Available in sheets for supersonic aircraft applications.
Crucible 422-M	C 0.28; Mn 0.84; Si 0.25; Cr 12.00; Ni 0.20; Mo 2.25; W 1.70; V 0.50; Fe bal	
USS 12MoV	C 0.25; Mn 0.50; Si 0.50; Ni 0.50; Cr 12.00; Mo 1.00; V 0.30	
Carpenter H-46	C 0.15; Mn 0.57; Si 0.40; Cr 11.50; Mo 0.45; Cb 0.25; V 0.30; Fe bal	
Rex-448 (British)	C 0.15; Cr 11.50; Mo 0.45; Cb 0.45; V 0.15; Fe bal	
Unitemp 1409 Cb	C 0.16; Cr 12.75; Cb 0.42; Fe bal	
Greek Ascoloy	C 0.15; Cr 13.00; Ni 2.00; W 3.00; Fe bal	
Unitemp 1416 MV	C 0.15; Cr 12.25; Mo 1.00; V 0.25	
Moly Ascoloy	C 0.08; Cr 13.00; Mo 2.00	
Unitemp 1420 WM	C 0.20; Cr 13.00; Ni 0.75; W 1.00; Mo 0.95; V 0.35	
Lapelloy (Unitemp 1430 MV)	C 0.30; Cr 11.50; Ni 0.35; Mo 2.75; V 0.25; Fe bal	
H-40 (British)	C 0.23; Mn 0.30; Si 0.45; Cr 2.70; Fe bal	Gas turbine rotors, casings, castings, and other uses needing high creep strength up to 600° F.
Croloy ½	C 0.10-0.20; Mn 0.50; Si 0.20; Cr 0.70; Mo 0.50	975° F
Croloy 1	C 0.15*; Mn 0.50; Si 0.50; Cr 1.00; Mo 0.50	1000° F
Croloy 1¼	C 0.15*; Mn 0.50; Si 0.75; Cr 1.25; Mo 0.50	1050° F
Croloy 2	C 0.15*; Mn 0.50; Si 0.50; Cr 2.00; Mo 0.50	1080° F
Croloy 2¼	C 0.15*; Mn 0.50; Si 0.50; Cr 2.25; Mo 1.00	1125° F
Croloy 3M	C 0.15*; Mn 0.50; Si 0.50; Cr 3.00; Mo 0.90	1125° F
Croloy 5	C 0.15*; Mn 0.50; Si 0.50; Cr 5.00; Mo 0.50	1150° F
Croloy 5 Ti	C 0.12*; Mn 0.50; Si 0.50; Cr 5.00; Mo 0.50; Ti 4 x C—0.70 max	1150° F
Croloy 5 Si	C 0.15*; Mn 0.50; Si 1.50; Cr 5.00; Mo 0.50	1150° F
Croloy 7	C 0.15*; Mn 0.50; Si 0.50; Cr 7.00; Mo 0.50	1150° F
Croloy 9M	C 0.15*; Mn 0.50; Si 0.50; Cr 9.00; Mo 1.00	1200° F
		Superheater tubing and pipe with temperature limits shown at left. Also used for oil refinery tubing. Croloy alloys are produced by Babcock & Wilcox. Like compositions are available from other producers under different tradenames.
Chromalloy (Unitemp 14CMV)	C 0.20; Cr 1.00; Mo 1.00; V 0.12; Fe bal	Sheet metal casing on aviation gas turbines.
Unitemp 14 HV	C 0.45; Cr 1.00; Mo 0.55; V 0.30; Fe bal	Same as above and steam and gas turbine bolting.
17-22A	C 0.44; Si 0.65; Cr 1.25; Mo 0.50; V 0.25; Fe bal	Same as above.
17-22 AS (Unitemp 14 MV)	C 0.30; Mn 0.55; Si 0.65; Cr 1.25; Mo 0.50; V 0.25; Fe bal	Steam and gas turbine bolting up to 1050° F; sheet metal casing assemblies. Axial-flow compressor blading at 800° F. Aircraft brakes. Compressor discs.
17-22 AV (Unitemp 14 MHV)	C 0.30; Si 0.65; Cr 1.25; Mo 0.50; V 0.55; Fe bal	High vanadium modification of above.
Unimach I (Thermold A)	C 0.35; Mn 0.45; Si 1.00; Cr 5.00; Mo 1.40; V 0.45	Ultrahigh strength for service up to 1000° F. Airframes, skin, fasteners, rivets, axles, rotors.
Unimach II (Thermold B)	C 0.35; Mn 0.45; Si 1.00; Cr 5.00; Mo 1.70; W 1.35	Same as above for ultrahigh strength at 1000° F.
Thermold J	C 0.53; Mn 0.35; Si 1.00; Cr 5.00; Ni 1.50; Mo 1.75; V 1.00	Ultrahigh strength up to 1000° F. Tensile strength 230,000 psi at 1000° F; 75,000 psi at 1200° F.
Crucible 56	C 0.40; Mn 0.55; Si 1.00; Cr 3.25; Mo 2.50; V 0.33	Bars, wire, sheets, plates, and billets for reforging. Tensile strength 228,000 psi at 1000° F, 154,000 psi at 1100° F.
Thermenol	Mo 1.70; Al 16.00; V 0.30; Fe bal	Oxidation resistant sheet metal parts.
Crucible 218	C 0.40; Mn 0.35; Si 1.00; Cr 5.00; Mo 1.40; V 0.45	Aircraft sheets, forgings, and fittings for high strength and resistance to softening up to 1000° F.
Pyromet 882	C 0.40; Mn 0.35; Si 1.10; Cr 5.00; Mo 1.35; V 0.40	Ultrahigh strength for service up to 1000° F; airframes, skin, fasteners, rivets, axles, rotors, spindles, etc.
Nu-Die V (Crucible)	C 0.40; Si 1.05; Cr 5.00; Mo 1.35; V 1.10	Bars, wire, sheets, and billets for reforging.
Chro-Mow (Crucible)	C 0.32; Mn 0.35; Si 1.00; Cr 5.00; Mo 1.35; W 1.35; V 0.20	Same as Crucible 218.
HTB-1 (Allegheny Ludlum)	C 1.02; Mn 0.35; Si 0.40; Cr 1.45; Al 1.00; Fe 1.00	Aircraft sheet forgings and fittings for high strength and resistance to softening up to 1000° F.
HTB-2 (Allegheny Ludlum)	C 0.58; Mn 0.30; Si 1.15; Cr 4.75; Mo 5.25; V 0.55	Used in high temperature bearing applications, primarily jet engines.

(Continued on Page S-8)

HIGH TEMPERATURE ALLOYS (continued)

Type: Ferritic Low Alloys and Stainless Alloys (continued)

Alloy	Composition %	Properties and Applications
HTB-3 (Allegheny Ludlum)	C 0.57; Mn 0.30; Si 1.15; Cr 4.75; Mo 5.25; V 0.55	Used in high temperature bearing applications, primarily jet engines.
Teton (Allegheny Ludlum)	C 1.00; Cr 1.50	For high hardness and wear resistance to 600° F. Ball and roller bearings.
Potomac A (Allegheny Ludlum)	C 0.40; Mn 0.30; Si 0.90; Cr 5.00; Mo 1.30; V 0.50	Aircraft sheets, forgings, and fittings for high strength and resistance to softening up to 1000° F.
Potomac M (Allegheny Ludlum)	C 0.40; Si 1.00; Cr 5.00; Mo 1.00; V 1.00	Similar to Potomac A.
HWD #1 (Firth Sterling)	C 0.35; Si 1.00; Cr 5.00; Mo 1.55; W 1.40; V 0.30	High temperature applications under 1000° F. Used mainly for structural parts requiring high strength and shock resistance.
HWD #2 (Firth Sterling)	C 0.37; Si 1.00; Cr 5.25; Mo 1.35; V 0.50	
HWD #3 (Firth Sterling)	C 0.40; Si 1.00; Cr 5.25; Mo 1.25; V 1.00	
THS-600	C 0.95-1.10; Mn 0.60-0.80; Si 0.85-1.25; Cr 1.25-1.65; Mo 0.25-0.35; P 0.025*; S 0.025*	For high hardness and wear resistance to 600° F; ball and roller bearings.
CBS-600	C 0.16-0.22; Mn 0.50-0.70; Si 0.90-1.25; Cr 1.25-1.65; Mo 0.90-1.10; P 0.040*; S 0.040*	For high hardness and wear resistance to 600° F; ball and roller bearings.
VascoJet 1000 (Vanadium Alloys)	C 0.40; Mn 0.30; Si 0.90; Cr 5.00; Mo 1.30; V 0.50; Fe bal	Ultrahigh strength for service up to 1000° F; airframes, skin, fasteners, rivets, axles, rotors, spindles, etc.
Vasco X-4 (Vanadium Alloys)	C 0.40; Mn 0.30; Si 0.30; Cr 4.25; Co 4.25; Mo 0.40; W 4.25; V 2.10; Fe bal	Ultrahigh strength material.
Vasco X-8 (Vanadium Alloys)	C 0.47; Mn 0.30; Si 0.90; Cr 7.75; Mo 1.35; V 1.40; Fe bal	Ultrahigh strength material.
Vasco X-21 (Vanadium Alloys)	C 0.33; Mn 0.20; Si 0.30; Cr 3.50; W 9.75; V 0.45; Fe bal	Ultrahigh strength material.
Vasco Y-9 (Vanadium Alloys)	C 0.48; Mn 0.30; Si 0.90; Cr 3.25; Mo 1.45; V 0.25; Fe bal	Ultrahigh strength material.
Lapelloy C	C 0.20; Mn 0.65-1.00; Si 0.50*; Cr 11.00-12.00; Ni 0.50*; Mo 2.50-3.00; P 0.03*; S 0.03*; Cu 1.75-2.25; N 0.06-0.10	Similar to Lapelloy, but with greater ductility and impact strength.
Carpenter 404	C 0.05; Mn 1.00; Si 0.50; Cr 11.00-12.50; Ni 1.25-2.00; N 0.03*	Highly stressed parts at temperatures up to 1050° F where joining is a problem.
AISI 410	C 0.15; Mn 1.00; Si 1.00; Cr 11.50-13.00	Highly stressed parts at temperatures up to 1200° F.
AISI 431	C 0.12-0.17; Mn 1.00; Si 1.00; Cr 15.50-17.00; Ni 1.50-2.50	Excellent toughness at relatively high hardness levels at temperatures from —100 to 1200° F.
VEM	C 0.70; Mn 0.50; Si 1.10; Cr 3.00; Mo 5.25	Resistant to wear and abrasion at high temperatures. For valve seat inserts, stems, slides, guides, and bearings.
636 Alloy	C 0.20-0.25; Mn 1.00*; Si 1.00*; Cr 12.00-14.00; Ni 0.50-1.00; Mo 0.75-1.25; W 0.75-1.25; P 0.04*; S 0.03*; V 0.20-0.50	Buckets and blades in steam turbines; aircraft valves.
No. 709 #1	C 0.30; Mn 0.55; Si 0.65; Cr 1.25; Mo 0.50; P 0.025*; S 0.025*; V 0.25	Used in aircraft, steam turbines, valves, pressure vessels; jet engine components.
No. 709 #2	C 0.45; Mn 0.55; Si 0.25; Cr 1.00; Mo 0.55; P 0.025*; S 0.025*; V 0.30	Used in aircraft, steam turbines, valves, pressure vessels; jet engine components.
H-11 Firedie (Columbia)	C 0.37; Mn 0.35; Si 1.00; Cr 5.25; Mo 1.35; V 0.50; Fe bal	Bars, hot rolled and hammer forged; blocks, discs, and ring forgings.
H-12 Alcodie (Columbia)	C 0.35; Mn 0.35; Si 1.00; Cr 5.00; Mo 1.45; W 1.25; V 0.45; Fe bal	
H-13 Vanadium Firedie (Columbia)	C 0.38; Mn 0.35; Si 1.00; Cr 5.25; Mo 1.35; V 1.05; Fe bal	
H-21 Formite #2 (Columbia)	C 0.33; Mn 0.30; Cr 3.25; W 9.50; V 0.50; Fe bal	
H-24 Formite #3 (Columbia)	C 0.50; Mn 0.30; Cr 3.25; W 15.50; V 0.50; Fe bal	
H-26 Clarite HW (Columbia)	C 0.58; Mn 0.25; Cr 4.00; W 18.00; V 0.70; Fe bal	
H-43 Molite HWL (Columbia)	C 0.63; Mn 0.25; Cr 4.00; Mo 8.25; V 1.90; Fe bal	
Acmite L (Columbia)	C 0.50; Mn 0.25; Cr 4.00; Co 5.00; W 18.00; V 1.10; Fe bal	
Cobite L (Columbia)	C 0.49; Mn 0.30; Cr 4.25; Co 8.75; W 18.50; V 1.90; Fe bal	
J-1300	C 0.08; Cr 14.00; Ni 33.00; Mo 4.00; W 6.50; Ti 2.00; Al 0.25; Zr 0.25; Fe bal	Austenitic grade for turbine wheels, couplings, shafts, bolts, at high temperature. Easy to forge.
G-192 (Allegheny Ludlum)	C 0.60; Mn 8.50; Cr 22.00; N 0.35; Fe bal	Nickel-free austenitic grades being developed by Allegheny Ludlum Steel Corp. for parts requiring high strength at elevated temperatures.
AF-183	C 0.30; Mn 18.00; Cr 12.00; Mo 3.00; V 0.75; N 0.20	
AF-71	C 0.30; Mn 18.00; Cr 12.00; Mo 3.00; V 0.75; N 0.30; B 0.20	
17-5 MnV (U. S. Steel)	C 0.10; Mn 15.00; Si 0.75*; Cr 17.00; Ni 5.00; Mo 2.00; V 0.75; N 0.35 min	Room and elevated temperature mechanical properties superior to those of commonly used 18-8 type austenitic stainless. For applications requiring bar and sheet material with high strength and corrosion resistance at room or elevated temperatures.

Alloy	Composition %	Properties and Applications
TYPE: CHROMIUM-NICKEL-IRON ALLOYS		
Unitemp 19-9DL	C 0.30; Mn 1.10; Si 0.60; Cr 19.00; Ni 9.00; Mo 1.25; W 1.20; Cb 0.40; Ti 0.30; Fe 66.00	Jet engine, gas turbine, and turbocharger buckets, bolts, rotors, and sheet metal assemblies. Bolting and valve trim for refineries, boilers, and steam turbines.
Unitemp 19-9DX	C 0.30; Mn 1.00; Si 0.55; Cr 19.20; Ni 9.00; Mo 1.50; W 1.20; Ti 0.55; Fe 66.00	Cb-free version of above.
Unitemp 19-9WX	C 0.11; Cr 20.50; Ni 8.50; Mo 0.50; W 1.50; Cb 1.30; Ti 0.20	Welding wire.
Incoloy Alloy	C 0.04; Mn 0.75; Si 0.35; Cr 20.50; Ni 32.50; Fe 45.50	Resistance to oxidation up to 1900° F. Similar to Inconel, but with improved resistance to attack by sulfur, green rot, molten cyanide salts; petrochemical equipment, heat treating fixtures.
Incoloy "T" Alloy	C 0.04; Mn 0.75; Si 0.35; Cr 20.50; Ni 32.50; Ti 1.00; Fe 44.50	Slightly better elevated temperature properties. Welded sheet metal components.
Croloy 15-15N	C 0.15*; Mn 2.00*; Si 0.75*; Cr 16.00; Ni 15.00; Mo 1.55; W 1.40; Cb 1.05; N 0.15*; Fe bal	Superheater tubing, steam piping.
17-14 Cu-Mo	C 0.12; Mn 0.75; Si 0.50; Cr 15.90; Ni 14.10; Mo 2.50; Cb 0.45; Ti 0.25; Cu 3.00; Fe bal	High strength austenitic stainless steel for service up to 1500° F. Aircraft gas turbines, boilers, etc.
Timken 16-25-6	C 0.08*; Mn 1.35; Si 0.70; Cr 16.00; Ni 25.00; Mo 6.00; N 0.15; Fe 50.00	Jet engine, gas turbine, and turbosupercharger wheels and buckets. Pickle chains. Bolting and sheet metal. Resists sea water.
Timken 16-15-6	C 0.07; Mn 7.50; Si 0.50; Cr 16.00; Ni 15.00; Mo 6.00; Fe 55.00; N 0.35	High temperature applications similar to above.
Discaloy 24	C 0.03; Mn 0.64; Si 0.92; Cr 13.10; Ni 25.50; Mo 2.83; Ti 1.83; Al 0.16; Fe bal	Turbine wheels, structural members, and fasteners in jet engine and gas turbine applications.
Croloy 16-8-2	C 0.10; Mn 1.50; Si 0.50; Cr 15.00; Ni 8.00; Mo 1.50; Fe bal	Welding wire for TP 316 and TP 347 steels.
A-286	C 0.05; Mn 1.35; Si 0.95; Cr 15.00; Ni 26.00; Mo 1.75; Ti 2.00; Al 0.20; V 0.30; Fe bal	Jet engine and gas turbine wheels, bolts, discs. High strength, nonmagnetic. Available in all mill product forms.
W-545	C 0.05; Mn 1.50; Si 0.40; Cr 13.50; Ni 26.00; Mo 1.50; Ti 2.85; Al 0.20; B 0.08; Fe bal	High temperature, highly stressed parts in missiles, gas turbines, steam turbines; also low temperature use in retaining rings and wedges for electrical apparatus. Nonmagnetic with high yield strength.
EME	C 0.10; Mn 0.50; Si 0.70; Cr 19.00; Ni 12.00; W 3.20; Cb 1.20; N 0.15; Fe 63.00	Steam turbine bolting and valve stems.
NA-22H (Cast) (Blaw-Knox)	C 0.50; Mn 1.30; Si 1.00; Cr 27.00; Ni 48.00; W 6.00; Fe bal	Strength and oxidation resistance for use at 2200° F. Furnace muffles, fans, retorts, annealing and radiant tubes, baffle support bars, etc.
Crucible HNM	C 0.30; Mn 3.50; Cr 18.50; Ni 9.50; P 0.20; Fe bal	Aircraft sheet and bar applications. Compressor blades and sheets for turbine engines; nonmagnetic.
Crucible HTX	C 0.45; Mn 8.50; Cr 21.00; Ni 8.50; Mo 1.50; P 0.25; Fe bal	Turbine wheels, high temperature sheets for aircraft.
Cast HTX	C 0.45; Mn 8.00; Si 0.50; Cr 21.00; Ni 8.00; Mo 1.50; P 0.22; N 0.20; Fe bal	High strength and rupture properties up to 1600° F.
AMS 5700	C 0.45; Mn 0.70; Si 0.60; Cr 14.00; Ni 14.00; Mo 0.50; W 2.50	Good high temperature properties and resistance to corrosion in exhaust gases.
D-979 (Allegheny Ludlum)	C 0.01; Cr 14.00; Ni 45.00; Mo 4.00; W 4.00; Ti 4.00; Al 1.00; B 0.01; Fe bal	Highly stressed jet engine parts up to 1600° F. Has good workability. Allows production in all mill forms and formability in users' operations.
V-57	C 0.08*; Mn 0.25*; Si 0.55; Cr 14.75; Ni 25.50; Mo 1.25; Ti 3.00; Al 0.25; V 0.30; B 0.0075; Fe bal	High stress rupture and endurance limit; good transverse ductility. Wheels for turbojet engines, turbine cases, afterburner nozzles, aircraft fastenings.
22-4-9 (Armco)	C 0.45-0.60; Mn 7.00-10.00; Si 1.00*; Cr 20.00-23.00; Ni 3.00-5.00; N 0.30-0.50; Fe bal	Austenitic, nonmagnetic alloy with high strength and hardness up to 1600° F with good scaling resistance. Steam valves and gas turbine parts, nonmagnetic roller bearings and balls.
Gaman-H (Crucible)	C 0.65; Mn 12.00; Cr 25.00; N 0.40	Stretch and oxidation resistance for use at 2100° F. Furnace rider sheets and combustion chambers.
17-7 PH (Armco)	C 0.09*; Mn 1.00*; Si 1.00*; Cr 16.00-18.00; Ni 6.50-7.75; Al 0.75-1.50; Fe bal	Hardenable by low temperature heat treatment to 180,000 psi min UTS and 150,000 psi min YS. Airframes, missiles, powerplants, etc. up to 900° F.
17-4 PH (Armco)	C 0.07*; Mn 1.00*; Si 1.00*; Cr 15.50-17.50; Ni 3.00-5.00; Cb 0.15-0.45; Cu 3.00-5.00; Fe bal	High strength, corrosion resistant, and no distortion by low temperature treatment. Valves, shafts, compressor blading, gears, bolting, and structural parts.
PH 15-7 Mo (Armco)	C 0.09*; Mn 1.00*; Si 1.00*; Cr 14.00-16.00; Ni 6.50-7.50; Mo 2.00-3.00; Al 0.75-1.50; Fe bal	Hardenable by low temperature treatment to 225,000 min UTS and 200,000 psi min YS. For aircraft and missile use up to 1000° F.
Unitemp 212 (Universal Cyclops)	C 0.08; Cr 16.00; Ni 25.00; Cb + Ta 0.50; Ti 4.00; Al 0.35; Zr 0.05; B 0.06; Fe bal	Jet engine and gas turbine buckets, bolts, discs, and other components which require particularly high strengths.
Unitemp 14-14W (Universal Cyclops)	C 0.45; Cr 14.00; Ni 14.00; W 2.40; Mo 0.35	Primarily used for exhaust valves and valve seat inserts; also for other engine components subjected to elevated temperatures.
AM-350	C 0.12; Mn 1.00; Si 0.50*; Cr 16.50; Ni 4.50; Mo 2.60; N 0.10; Fe bal	Sheet applications, compressor blades. Structural applications in airframes, missiles up to 900° F. Combines ease of 300 series fabrication with heat treatment properties of 400 grade stainless.
AM-355	C 0.12; Mn 1.00; Si 0.50*; Cr 15.50; Ni 4.50; Mo 2.75; N 0.10; Fe bal	Bar and billet version of AM-350 with similar properties in heavy sections.
Multimet Alloy (Wrought)	C 0.16*; Mn 1.50; Si 1.00*; Cr 21.00; Ni 20.00; Co 20.00; Mo 3.00; W 2.50; N 0.20*; Cb + Ta 1.25*; Fe bal	Good oxidation and corrosion resistance up to 2000° F. Used where good ductility is a prime factor. Jet engine tail pipes, afterburners, and nozzle assemblies.
(Cast)	C 0.20*; Mn 1.50; Si 1.00*; Cr 21.00; Ni 20.00; Co 20.00; Mo 3.00; W 2.50; N 0.20*; Cb + Ta 1.25*; Fe bal	
USS Stainless W	C 0.10; Mn 1.00; Ni 7.00; Cr 17.00; Ti 1.00	Precipitation hardening steel with low distortion on heat treatment. Can be age hardened to room temperature tensile strength of 200,000 psi. High strength, corrosion resisting uses to 600° F.
S-590	C 0.40; Mn 1.50; Si 0.70; Cr 20.00; Ni 20.00; Co 20.00; Mo 4.00; W 4.00; Fe 24.00; Cb 4.00	Wheels and buckets in stationary gas turbines.

(Continued on Page S-10)

HIGH TEMPERATURE ALLOYS (continued)

Alloy	Composition %	Properties and Applications
Refractaloy 26	C 0.03; Mn 0.80; Si 1.00; Cr 18.00; Ni 38.00; Co 20.00; Mo 3.20; Ti 2.60; Al 0.20; Fe bal	Superior strength at temperatures above 1250° F. Low magnetic response, good corrosion resistance. Buckets, bolts, coiled and flat springs, turbine discs.
Refractaloy 70	C 0.04; Mn 2.00; Si 0.30; Cr 20.00; Ni 21.00; Co 30.00; Mo 8.00; W 4.20; Fe bal	Gas turbine blades and nozzle vanes. Flat and coiled springs. High endurance limit at 1200° F.
Refractaloy 80	C 0.10; Mn 0.60; Si 0.70; Cr 20.00; Ni 20.00; Co 30.00; Mo 10.00; W 5.00; Fe bal	Used extensively for creep testing holders. High strength above 1300° F.
K42B	C 0.03; Mn 0.70; Si 0.70; Cr 18.00; Ni 42.00; Co 22.00; Ti 2.10; Al 0.20; Fe bal	High resistance to heat and corrosion. Low creep up to 1350° F. Gas and steam turbine blades, bolts.
TYPE: NICKEL-BASE ALLOYS		
Nicrotung	C 0.10; Cr 12.00; Co 10.00; W 8.00; Ti 4.00; Al 4.00; B 0.05; Zr 0.05; Ni bal	High temperature cast alloy for applications in highly stressed parts at high temperatures in the 1500-2000° F range.
Inconel Alloy	C 0.04; Mn 0.35; Si 0.20; Cr 15.50; Ni 76.00; Fe 7.00	Resists oxidation up to 2200° F, carburizing and nitriding atmospheres, and corrosion. Manifolds, combustion liners, domes, transition liners.
Inconel "702" Alloy	C 0.04; Mn 0.10; Si 0.25; Cr 15.50; Ni 79.00; Al 3.00; Fe 0.50	Welded aero sheet metal components; exceptional resistance to oxidation over 1800° F.
Nimonic 75 Alloy	C 0.08-0.15; Mn 1.00*; Si 1.00*; Cr 18.00-21.00; Ti 0.20-0.60; Fe 5.00*; Ni bal	Similar to Inconel Alloy. Flame tubes, afterburners.
Inconel "M" Alloy	C 0.03; Mn 2.25; Si 0.10; Cr 16.00; Ni 71.50; Ti 3.00; Al 0.05; Fe 7.00	Age-hardenable Inconel Alloy. High strength and resistance to oxidation and leaded fuels. Valves for aviation piston type engines.
Inconel "X" Alloy	C 0.04; Mn 0.70; Si 0.30; Cr 15.00; Ni 73.00; Cb 0.90; Ti 2.50; Al 0.90; Fe 7.00	Age-hardenable Inconel Alloy. Oxidation resistance, high strength up to 1500° F. Blades, rotors, bolting, welded sheet metal components.
Inconel "X," "550" Alloy	C 0.04; Mn 0.70; Si 0.40; Cr 15.00; Ni 73.00; Cb 0.90; Ti 2.40; Al 0.90; Fe 7.00	Inconel "X" with increased hardener; turbine blades.
Nimonic 80A Alloy	C 0.10*; Mn 0.10*; Si 1.00*; Cr 18.00-21.00; Co 2.00*; Ti 1.80-2.70; Al 0.50-1.80; Fe 5.00*; Ni bal	Rotor turbine blades—up to 1400° F; stator blades.
Nimonic 90 Alloy	C 0.10*; Mn 1.00*; Si 1.50*; Cr 18.00-21.00; Co 15.00-21.00; Ti 1.80-3.00; Al 0.80-2.00; Fe 5.00*; Ni bal	Rotor turbine blades—up to 1550° F.
Inconel "700" Alloy	C 0.13; Mn 0.08; Si 0.25; Cr 15.00; Ni 46.00; Co 29.00; Mo 3.00; Ti 2.20; Al 3.20; Fe 0.80	Rotor turbine blades—up to 1650° F.
Hastelloy Alloy B (Wrought)	C 0.05*; Mn 1.00*; Si 1.00*; Cr 1.00*; Co 2.50*; Mo 28.00; Fe 5.50; V 0.40*; Ni bal	Outstanding resistance to hot hydrochloric acid, wet hydrogen chloride gas and other reducing agents. Oxidation rate in air is low enough for use up to 1400° F.
(Cast)	C 0.12*; Mn 1.00*; Si 1.00*; Cr 1.00*; Co 2.50*; Mo 28.00; Fe 5.50; V 0.60*; Ni bal	
Hastelloy Alloy C (Wrought)	C 0.08*; Mn 1.00*; Si 1.00*; Cr 15.50; Co 2.50*; Mo 16.00; W 3.75; Fe 5.50; V 0.35*; Ni bal	Good all around high temperature properties, particularly for parts highly stressed or subjected to repeated thermal shock at 1600-1800° F. Withstands strong oxidizing conditions, sea water and acetic, formic, phosphoric, sulfurous, and sulfuric acids.
(Cast)	C 0.12*; Mn 1.00*; Si 1.00*; Cr 16.50; Co 2.50*; Mo 17.00; W 4.50; Fe 5.50; V 0.40*; Ni bal	
Hastelloy Alloy R-235 (Wrought)	C 0.16*; Mn 1.00*; Si 1.00*; Cr 15.00; Co 2.50*; Mo 5.00; Ti 2.50; Al 2.00; Fe 10.00; Ni bal	Vacuum melted, precipitation hardening alloy with excellent strength up to 1750° F.
GMR-235 (Cast)	C 0.20*; Mn 0.25*; Si 0.60*; Cr 15.50; Mo 5.25; Ti 2.00; Al 3.00; Fe 10.00; B 0.07; Ni bal	Has excellent stress rupture properties at high stresses up to 1700° F. Vacuum melted.
GMR-235D (Cast)	C 0.15; Mn 0.10*; Si 0.30*; Cr 15.50; Mo 5.25; Ti 2.50; Al 3.60; Fe 4.25; B 0.07; Ni bal	Investment cast. Vacuum melted. Average rupture life 160 hours, 1600° F, 28,000 psi. Applications same as GMR-235.
Incoloy "901" Alloy	C 0.05; Mn 0.50; Si 0.35; Cr 13.00; Ni 40.00; Mo 6.00; Ti 2.50; Al 0.20; B 0.01-0.05; Fe bal	Matches mechanical properties of Inconel "X" at temperatures to 1350° F; turbine discs and parts where high tensile, creep, and rupture strengths are needed in the 1000-1400° F range.
Inconel "713C" Alloy (Cast)	C 0.12; Mn 0.15; Si 0.40; Cr 13.00; Mo 4.50; Cb 2.25; Ti 0.60; Al 6.00; Fe 1.00; Ni bal	Has high rupture strength to 1700° F and above, exceptional resistance to thermal fatigue, good castability; turbine blades in advanced engines.
Inconel "717C" Alloy (Cast)	C 0.12; Cr 11.00; Co 8.00; Mo 4.50; Cb 2.00; Ti 1.00; Al 7.50; Ni bal	Turbine blades for 1800° F operation.
Inconel "718" Alloy	C 0.05; Mn 0.30; Si 0.40; Cr 18.00; Ni 53.00; Mo 3.00; Ti 0.8; Al 0.40; Cb + Ta 5.00	Age hardenable alloy with exceptionally high yield strength up to 1400° F. Weldable, corrosion resistant.
Hastelloy Alloy X (Wrought) Unitemp HX	C 0.10; Mn 1.00*; Si 1.00*; Cr 22.00; Co 1.50; Mo 9.00; W 0.60; Fe 18.50; Ni bal	Good scale resistance to 2200° F. Excellent for cast and fabricated heat treating equipment.
(Cast)	C 0.20*; Mn 1.00*; Si 1.00*; Cr 22.00; Co 1.50; Mo 9.00; W 0.60; Fe 18.50; Ni bal	
Waspaloy	C 0.05; Cr 19.50; Co 13.50; Mo 4.00; Ti 3.00; Al 1.25; Zr 0.06; B 0.005; Fe 2.00*; Ni bal	Gas turbine buckets. Largely vacuum melted.
Udimet 500	C 0.15*; Mn 0.75; Si 0.75; Cr 20.00; Co 13.00; Mo 4.00; Ti 3.00; Al 2.75; Fe 4.00*; Ni bal	Gas turbine components. High strength at elevated temperatures. Vacuum melted.
Unitemp 1753	C 0.24; Cr 16.25; W 8.40; Mo 1.60; Co 7.20; Ti 3.15; Al 1.90; Zr 0.06; B 0.008; Fe 9.50; Ni bal	Gas turbine components where especially high strength at elevated temperatures is required.
Thetalloy (Cast)	Mn 2.50; Cr 25.00; Co 12.50; Mo 3.00; W 7.00; Ni bal	Gas turbine diaphragms.

Alloy	Composition %	Properties and Applications
Rene 41	C 0.09; Cr 19.00; Co 11.00; Mo 10.00; Ti 3.10; Al 1.50; B 0.005; Ni bal	High strength to 1800° F. Readily forged, formed and welded. Jet engine parts.
J-1500	C 0.15; Cr 20.00; Co 10.00; Mo 10.00; Ti 3.00; Al 1.00; Ni bal	Turbine buckets and components. High strength to 1600° F.
M-252 (GE)	C 0.10; Mn 1.00; Si 0.70; Cr 19.00; Ni 54.00; Co 10.00; Mo 10.00; Ti 2.50; Al 0.75; B 0.005; Fe 2.00	Gas turbine buckets, torque rings. Vacuum melted.
Illium G	C 0.25; Mn 0.35; Si 0.90; Cr 22.00; Ni 58.50; Mo 6.00; Fe 6.00; Cu 6.00	High temperature and corrosion resistant applications.
Illium R	C 0.07; Mn 0.40; Si 0.11; Cr 22.00; Ni 64.00; Mo 5.00; Fe 6.00; Cu 2.50	High temperature and corrosion resistant applications.

TYPE: COBALT-BASE ALLOYS

Haynes Stellite Alloy No. 21 (Cast)	C 0.30*; Mn 1.00*; Si 1.00*; Cr 27.00; Ni 2.75; Mo 5.50; Fe 2.00*; Co bal	Resists oxidizing and reducing atmospheres up to 2100° F. Good high temperature strength, thermal shock resistant.
Haynes Stellite Alloy No. 30 (Cast)	C 0.50*; Mn 1.00*; Si 1.00*; Cr 26.00; Ni 15.00; Mo 6.00; Fe 2.00*; Co bal	Excellent creep properties at 1600° F. Modulus of elasticity does not drop off rapidly and endurance properties are good.
Haynes Stellite Alloy No. 31 (Cast) (X-40)	C 0.55*; Mn 1.00*; Si 1.00*; Cr 25.50; Ni 10.50; W 7.50; Fe 2.00*; Co bal	Good endurance and creep properties. Stress-rupture strength 27,000 psi at 1500° F for 100 hours.
Haynes Alloy No. 36 (Cast)	C 0.45*; Mn 1.50*; Si 1.00*; Cr 18.50; Ni 10.00; W 15.00; Fe 2.00*; B 0.05*; Co bal	Cast modification of Alloy No. 25. Excellent creep and rupture properties. Good ductility.
Haynes Alloy No. 25 (Wrought)	C 0.15*; Mn 1.50; Si 1.00*; Cr 20.00; Ni 10.00; W 15.00; Fe 3.00*; Co bal	Exceptional high temperature strength. Good forming and welding characteristics. Used for nozzle partitions, afterburner assemblies.
WF-11 (Crucible) Unitemp L-605 Altemp L-605	C 0.15; Mn 1.50; Si 0.50; Cr 20.00; Ni 10.00; W 15.00; Fe 3.00*; Co bal	Afterburner sheets, turbine rings, nozzle vanes in turbine engines—6000 psi for 100 hours at 1800° F.
J-1570	C 0.20; Cr 20.00; Ni 28.00; W 6.00; Ti 4.00; Co bal	Gas turbine buckets and high temperature sheet metal parts. Vacuum melted. Can be forged and welded.
S-816	C 0.38; Mn 1.50; Si 0.70; Cr 20.00; Ni 20.00; Co 43.00; Mo 4.00; W 4.00; Cb 4.00; Fe 3.00	Jet engine buckets. High temperature springs. Steam turbine bolting and buckets.
V-36 (Allegheny Ludlum)	C 0.31; Mn 0.90; Si 0.50; Cr 25.00; Ni 20.00; Co 42.00; Mo 4.00; W 2.00; Cb 2.20; Fe 3.00	Sheet uses over 1600° F requiring high tensile, rupture, and creep strengths.
Nivco	C 0.02; Mn 0.35; Si 0.15; Ni 22.50; Co 73.50; Ti 1.80; Al 0.22; Fe 0.30; P 0.005; S 0.009; Zr 1.10	High damping material with good high temperature strength for applications to 1200° F. Applications include low noise gearing, Precipitron wires, nonvibratory tool supports, and compressor blades.
Haynes Alloy No. 151 (Cast)	C 0.48; Mn 1.00*; Si 1.00*; Cr 20.00; W 12.75; Ni + Fe 3.00*; B 0.05; Co bal	For integrally cast turbine wheels operating at 1200-1600° F. For stationary turbine vanes operating at 1700-1800° F.

TYPE: MOLYBDENUM-BASE ALLOYS

Climelt Molybdenum (Climax Molybdenum) Refractomet Pure Molybdenum (Universal Cyclops)	Electric and electronic parts; rocket nozzles; furnace parts. Boring bars, grinding quills, wear resistant room temperature uses.
Pure Molybdenum (General Electric)	Missile and rocket parts, electrical contacts, semiconductor devices, lamps, and electronic tubes.
Refractomet Molybdenum 0.5% Ti Alloy Climelt Molybdenum 0.5% Ti Alloy	Piercer points; experimental gas turbine buckets and guide vanes. Useful strength at temperatures above 1600° F greater than that of any other commercially available material. Must be protected against oxidation at elevated temperatures.
Climelt Molybdenum 30% W	Ultrahigh temperature service material. Has better corrosion resistance than unalloyed molybdenum in some mediums. Nozzles and other missile parts.

TYPE: TUNGSTEN-BASE ALLOYS

Pure Tungsten	Tensile strength of 50,000 to 600,000 psi with up to 4% elongation depending on form and work history. Uses are same as for molybdenum.
Tungsten-Molybdenum Alloy (50-50)	Tensile strength of 60,000 to 300,000 psi depending on form and work history, and 2% to 5% ductility depending on treatment. Used for rocket and missile parts.

*Indicates maximum.

Note: This chart does not include the AISI grades of stainless and heat resistant steels, many of which are specified for high temperature applications.

STAINLESS AND HEAT-RESISTANT STEELS

AISI No.	C	Mn Max	Si Max	Cr	Ni	P Max	S Max	Properties and Applications
201	0.15 max Other: N 0.25 max	5.5–7.50	1.00	16–18	3.5–5.5	0.060	0.030	Low-nickel alternate for 301; somewhat higher strength than 301. General applications similar to 301.
202	0.15 max Other: N 0.25 max	7.5–10.00	1.00	17–19	4–6	0.060	0.030	Low-nickel alternate for 302; somewhat higher strength than 302. General applications similar to 302.
301	0.15 max	2.00	1.00	16–18	6–8	0.045	0.030	Rapid work hardening. Railroad cars, trailer bodies, aircraft structurals.
302	0.15 max	2.00	1.00	17–19	8–10	0.045	0.030	General purpose, chromium nickel type. Trim, food handling equipment, jewelry, aircraft cowling, antennas, springs, architectural, cookware.

(Continued on Page S-12)

STAINLESS AND HEAT RESISTANT STEELS (continued)

AISI No.	C	Mn Max	Si Max	Cr	Ni	P Max	S Max	Properties and Applications
302B	0.15 max	2.00	2.0–3.0	17–19	8–10	0.045	0.030	Higher scaling resistance at elevated temperatures than 302. Furnace parts, still liners, heating elements.
303	0.15 max Other: Mo 0.60 max‡; Zr 0.60 max‡	2.00	1.00	17–19	8–10	0.20	0.15 min	Free machining; lower galling and seizing tendency than 302. Screw machine products, shafts, valves.
303Se	0.15 max Other: Se 0.15 min	2.00	1.00	17–19	8–10	0.20	0.06	Better transverse properties, lower machinability, better finish than 303; improved workability.
304	0.08 max	2.00	1.00	18–20	8–12	0.045	0.030	General purpose alloy for welding. Chemical and food processing equipment, recording wire.
304L	0.03 max	2.00	1.00	18–20	8–12	0.045	0.030	Weldments for corrosive conditions where intergranular carbide precipitation must be avoided. Atomic energy applications.
305	0.12 max	2.00	1.00	17–19	10–13	0.045	0.030	Low work-hardening rate. Maximum plasticity for forming, spinning, cold heading.
308	0.08 max	2.00	1.00	19–21	10–12	0.045	0.030	Welding rods and electrodes.
309	0.20 max	2.00	1.00	22–24	12–15	0.045	0.030	High scale resistance, good strength at high temperatures. Aircraft heaters, heat treating equipment, annealing covers, furnace parts.
309S	0.08 max	2.00	1.00	22–24	12–15	0.045	0.030	Weldments with high scale resistance.
310	0.25 max	2.00	1.50	24–26	19–22	0.045	0.030	Like 309 but even higher heat resistance. Excellent for general use. Heat exchangers, furnace parts, combustion chambers, welding rods.
310S	0.08 max	2.00	1.50	24–26	19–22	0.045	0.030	Like 309S but has even higher heat resistance.
314	0.25 max	2.00	1.5–3.0	23–26	19–22	0.045	0.030	Highest heat resistance. Uses similar to 310. Resistant to carburizing. Heat treating fixtures.
316	0.08 max Other: Mo 2.00–3.00	2.00	1.00	16–18	10–14	0.045	0.030	Higher resistance to corrosives affecting other stainless steels. High creep resistance. High temperature parts, chemical and pulp handling equipment, photographic and food equipment.
316L	0.03 max Other: Mo 2.00–3.00	2.00	1.00	16–18	10–14	0.045	0.030	Version of 316 for weldments where intergranular carbide precipitation must be avoided. Permits stress relief at 1550–1650° F.
317	0.08 max Other: Mo 3.00–4.00	2.00	1.00	18–20	11–15	0.045	0.030	Higher in corrosion resistance than 316.
D319	0.07 max	2.00	1.00	17.5–19.5	11–15	0.045	0.030	Modification of 316. Slightly superior to 316 for chemical service.
321	0.08 max Other: Ti 5xC min	2.00	1.00	17–19	9–12	0.045	0.030	For weldments subject to severely corrosive conditions and service in 800–1650° F range. Aircraft exhaust manifolds, boiler shells, expansion joints, process equipment.
347	0.08 max Other: Cb-Ta 10xC min	2.00	1.00	17–19	9–13	0.045	0.030	For uses similar to 321. More widely used for welded process equipment.
348	0.08 max Other: Cb-Ta 10xC min, Ta 0.10 max	2.00	1.00	17–19	9–13	0.045	0.030	Equivalent to 347. For atomic energy applications due to low retentivity.
403*	0.15 max	1.00	0.50	11.5–13	.....	0.040	0.030	Steam turbine blades, jet engine compressor blades, highly stressed parts.
405	0.08 max Other: Al 0.10–0.30	1.00	1.00	11.5–14.5	.....	0.040	0.030	Nonhardenable. For welded assemblies where air-hardening of 410 or 403 is objectionable.
410*	0.15 max	1.00	1.00	11.5–13.5	.....	0.040	0.030	General purpose corrosion and heat resistance. Hardenable by heat treatment. Coal screens, low priced cutlery, machine parts, valve trim.
414*	0.15 max	1.00	1.00	11.5–13.5	1.25–2.50	0.040	0.030	High-strength version of 410. Rules and straight edges, mild springs, scraper knives.
416*	0.15 max Other: Mo 0.60 max‡; Zr 0.60 max‡	1.25	1.00	12–14	.....	0.06	0.15 min	Free machining. Bolts, nuts, screws, carburetor parts, fishing reels, golf club heads, instrument parts, screw machine parts, valve trim.
416Se*	0.15 max Other: Se 0.15 min	1.25	1.00	12–14	.....	0.06	0.06	Higher transverse properties, better finish, lower machinability than 416; improved workability.
420*	Over 0.15	1.00	1.00	12–14	.....	0.040	0.030	High hardness from heat treatment. General purpose cutlery grade. Surgical instruments.
430	0.12 max	1.00	1.00	14–18	.....	0.040	0.030	General purpose, nonhardenable chromium type. Decorative trim, nitric acid tanks, annealing baskets, auto trim, sinks.
430F	0.12 max Other: Mo 0.60 max‡; Zr 0.60 max‡	1.25	1.00	14–18	.....	0.06	0.15 min	Free-machining bars. Screw machine parts, screws and other fasteners.
430FSe	0.12 max Other: Se 0.15 min	1.25	1.00	14–18	.....	0.06	0.06	Free machining, retaining forgeability. Fine finish quality. Similar to 430F.
431*	0.20 max	1.00	1.00	15–17	1.25–2.50	0.040	0.030	Special purpose hardenable type. Aircraft fittings, bolts, paper machinery, windshield wiper arms, beater bars, springs.
440A*	0.60–0.75 Other: Mo 0.75 max	1.00	1.00	16–18	.....	0.040	0.030	High strength and corrosion resistance. Hardenable by heat treatment. Toughest high chrome cutlery grade. bearings, seaming rolls, surgical tools.
440B*	0.75–0.95 Other: Mo 0.75 max	1.00	1.00	16–18	.....	0.040	0.030	Cutlery grade. Uses similar to 440A.
440C*	0.95–1.20 Other: Mo 0.75 max	1.00	1.00	16–18	.....	0.040	0.030	Ball bearing grade. Also bushings, valve parts, cutlery.
446	0.20 max Other: N 0.25 max	1.50	1.00	23–27	.....	0.040	0.030	Resistance to high-temperature scaling, hot sulfur-bearing gases and oxidizing acids.
501*	Over 0.10 Other: Mo 0.40–0.65	1.00	1.00	4–6	.....	0.040	0.030	Moderate resistance to scaling but limited corrosion resistance. Oil industry equipment—stills, heat exchangers, hot lines.
502*	0.10 max Other: Mo 0.40–0.65	1.00	1.00	4–6	.....	0.040	0.030	Uses similar to 501.

‡At producer's option; reported only when intentionally added.

*Respond to heat treatment to develop a wide range of mechanical properties.

CAST HIGH ALLOYS

Corrosion & Heat Resistant

ACI Designation	Equiv. (Wrought)	Nominal Composition %	Outstanding Properties and Typical Uses
CA-15	410	C 0.15 max; Mn 1.00 max; Si 1.50 max; Cr 11.5-14.0; Ni 1.0 max; Mo 0.5 max*; Fe bal	Hardenability, 144 to 400 BHN. Good atmospheric corrosion resistance. Pump casings, bushings and liners, impellers, shafts, turbine blades, stuffing boxes, valve bodies and trim, fittings, furnace burner tips, and pilot cones.
CA-40	420	C 0.20-0.40; Mn 1.00 max; Si 1.50 max; Cr 11.5-14.0; Ni 1.0 max; Mo 0.5 max*; Fe bal	Hardenability, up to 500 BHN. Corrosion resistance same as CA-15. Choppers, cutting blades, cylinder liners, pump parts, steam turbine parts, molds, dies.
CB-30	431	C 0.30 max; Mn 1.00 max; Si 1.00 max; Cr 18-22; Ni 2.0; Fe bal	Resists nitric acid, alkali, and many organic chemicals. Good machinability. Furnace brackets and hangers, pump parts, rabble arms, tube supports, valve bodies and parts.
CC-50	446	C 0.50 max; Mn 1.00 max; Si 1.00 max; Cr 26-30; Ni 4.0 max; Fe bal	Magnetic, good machinability; resists dilute sulfuric acid, mixed nitric and sulfuric acids, and oxidizing acids. Bushings, cylinder liners, pump casings and impellers, valve bodies and seats.
CD-4MCu	...	C 0.040 max; Mn 1.00 max; Si 1.00 max; Cr 25-27; Ni 4.75-6.00; Mo 1.75-2.25; Cu 2.75-3.25; Fe bal	High strength, precipitation hardening alloy with corrosion resistance equal to CF-8. Hardenability, 290 to 320 Brinell. Valve trim, pumps, fittings, high pressure parts, gears.
CE-30	312	C 0.30 max; Mn 1.50 max; Si 2.00 max; Cr 26-30; Ni 8-11; Fe bal	Better strength and ductility than CC-50; useful where castings cannot be heat treated. Resists sulfurous acid and sulfites. Process industry equipment such as digester fittings, fractionating towers, pipings, pump bodies and casings, valve bodies and parts.
CF-3	304L	C 0.03 max; Mn 1.50 max; Si 2.00 max; Cr 17-21; Ni 8-12; Fe bal	Lower carbon modification of CF-8. Useful where castings cannot be heat treated after welding.
CF-8	304	C 0.08 max; Mn 1.50 max; Si 2.00 max; Cr 18-21; Ni 8-11; Fe bal	High impact strength at low temperatures. Resists strong oxidants such as boiling nitric acid. Autoclaves, blast furnace bushings, filter press plates, hardware, headers and heating coils, pump parts, spray nozzles, valve parts.
CF-20	302	C 0.20 max; Mn 1.50 max; Si 2.00 max; Cr 18-21; Ni 8-11; Fe bal	High ductility and impact strength. Satisfactory in many oxidizing environments. Cylinder liners, pumps, return bends, rolls, circuit breaker parts, valve parts.
CF-3M	316L	C 0.03 max; Mn 1.50 max; Si 1.50 max; Cr 17-21; Ni 9-13; Mo 2.0-3.0; Fe bal	Lower carbon modification of CF-8M. Useful where castings cannot be heat treated after welding.
CF-8M	316	C 0.08 max; Mn 1.50 max; Si 2.00 max; Cr 18-21; Ni 9-12; Mo 2.0-3.0; Fe bal	Used up to 1000° F—ductile and strong. Resists reducing solutions and pitting corrosion in sea water. Agitators, evaporator parts, jet engine components, spray nozzles, high pressure steam valves.
CF-12M	316	C 0.12 max; Mn 1.50 max; Si 2.00 max; Cr 18-21; Ni 9-12; Mo 2.0-3.0; Fe bal	Preferred over CF-8M for operating temperatures above 1200° F; corrosion resistance not quite as good as CF-8M. Agitators, evaporator parts, jet engine components, spray nozzles, high pressure steam valves.
CF-8C	347	C 0.08 max; Mn 1.50 max; Si 2.00 max; Cr 18-21; Ni 9-12; Cb 8 x C min, 1.0 max or Cb + Ta 10 x C min, 1.35 max; Fe bal	Suitable for field welding. Corrosion resistance similar to CF-8. Aircraft shroud assemblies, autoclaves, chemical tubing, fittings, jet engine parts, marine fittings.
CF-16F	303	C 0.16 max; Mn 1.50 max; Si 2.00 max; Cr 18-21; Ni 9-12; Se 0.20-0.35; Mo 1.50 max; P 0.17 max; Fe bal	Improved machinability, good welding characteristics. Corrosion resistance inferior to CF-20, but adequate for many purposes. Bearings, bushings, fittings, pump and machinery parts.
CG-8M	317	C 0.08 max; Mn 1.50 max; Si 1.50 max; Cr 18-21; Ni 9-13; Mo 3.0-4.0; Fe bal	Properties similar to CF-8M, but preferred in reducing environments. Especially useful for applications in the pulp and paper industry.
CH-20	309	C 0.20 max; Mn 1.50 max; Si 2.00 max; Cr 22-26; Ni 12-15; Fe bal	More ductile than CE-30 but not as strong; stronger than CF-8 but not as ductile. Resists hot dilute sulfuric acid. Digester fittings, roasting equipment, valves.
CK-20	310	C 0.20 max; Mn 1.50 max; Si 2.00 max; Cr 23-27; Ni 19-22; Fe bal	Withstands elevated temperatures, resists dilute sulfuric acid. Digesters, filter press parts, fittings, jet engine parts, pumps, valves.
CN-7M	...	C 0.07 max; Mn 1.50 max; Si 1.50 max; Cr 19-22; Ni 27.5-30.5; Mo 1.75-2.50; Cu 3.00 min; Fe bal	Good machining and fair welding properties, nonmagnetic. Resists: Sulfuric acid, reducing chemicals, dilute hydrochloric acid, hot chlorides and nitric acid. Filter parts, heat exchanger parts, pickling rolls, hooks, and racks.
HA	...	C 0.20 max; Mn 0.35-0.65; Si 1.00 max; Mo 0.90-1.20; Cr 8-10; Fe bal	Maximum use temperature: 1300° F. Fan blades for hot gases, trunnions for glass rolls.
HC	446	C 0.50 max; Mn 1.00 max; Si 2.00 max; Mo 0.5 max*; Cr 26-30; Ni 4 max; Fe bal	Maximum use temperature: 1200° F with moderately heavy loading; 1900° F with light loading. Used in sulfur atmosphere when heavy loading is not involved; in ore roasting furnaces for parts such as rabble arms and blades.
HD	327	C 0.50 max; Mn 1.50 max; Si 2.00 max; Mo 0.5 max*; Cr 26-30; Ni 4-7; Fe bal	Properties and uses same as Type HC with greater strength at elevated temperatures. Useful in sulfur atmospheres. Ore roasting furnace parts, salt pots, grate bars.
HE	312	C 0.20-0.50; Mn 2.00 max; Si 2.00 max; Mo 0.5 max*; Cr 26-30; Ni 8-11; Fe bal	Maximum use temperature: 2000° F. Good corrosion resistance and ductility; moderate strength at elevated temperatures. Stands sulfur atmospheres.
HF	302B	C 0.20-0.40; Mn 2.00 max; Si 2.00 max; Mo 0.5 max*; Cr 19-23; Ni 9-12; Fe bal	Maximum use temperature: 1600° F. Good corrosion resistance in the range 1200-1600° F. Oil refineries for tube supports and beams; cement mill parts, ore roasting furnace parts, heat treating furnaces.
HH	309	C 0.20-0.50; Mn 2.00 max; Si 2.00 max; Mo 0.5 max*; N 0.2 max; Cr 24-28; Ni 11-14; Fe bal	Maximum use temperature: 2000° F. High strength and oxidation resistance at elevated temperatures. Depending on composition, the alloy can be partially ferritic or fully austenitic. Tube supports and beams in oil refineries, ore roasting furnace parts, and heat treating parts.
HI	...	C 0.20-0.50; Mn 2.00 max; Si 2.00 max; Mo 0.5 max*; Cr 26-30; Ni 14-18; Fe bal	Maximum use temperature: 2150° F. Cast retorts for magnesium production.
HK	310	C 0.20-0.60; Mn 2.00 max; Si 2.00 max; Mo 0.5 max*; Cr 24-28; Ni 18-22; Fe bal	Maximum use temperature: 2100° F. Resists hot gas corrosion better than Type HH. Not recommended where severe thermal shock is involved. Used where high creep strength is needed; jet engines, gas turbines, furnace parts.
HL	...	C 0.20-0.60; Mn 2.00 max; Si 2.00 max; Mo 0.5 max*; Cr 28-32; Ni 18-22; Fe bal	Maximum use temperature: 1800° F. Good corrosion resistance in sulfur atmospheres. Gas dissociation equipment, fixtures.
HN	...	C 0.20-0.50; Mn 2.00 max; Si 2.00 max; Mo 0.5 max*; Cr 19-23; Ni 23-27; Fe bal	Good high temperature strength and corrosion resistance in chemically reactive media. Brazing fixtures for use up to 2060° F.
HT	330	C 0.35-0.75; Mn 2.00 max; Si 2.50 max; Mo 0.5 max*; Cr 13-17; Ni 33-37; Fe bal	Maximum use temperature: 2100° F in oxidizing and 2000° F in reducing atmospheres. Excellent service life where subject to rapid heating and cooling. Heat treating furnace parts such as rails, rolls, discs, chains, boxes, pots, and fixtures subject to cyclic heating. Also used for glass rolls, enameling racks.
HU	...	C 0.35-0.75; Mn 2.00 max; Si 2.50 max; Mo 0.5 max*; Cr 17-21; Ni 37-41; Fe bal	Strength and corrosion resistance at high temperatures; similar to HT. Used where improved resistance to hot gas corrosion is required.

(Continued on Page S-14)

CAST HIGH ALLOYS (continued)

ACI Designation	Equiv. (Wrought)	Nominal Composition %	Outstanding Properties and Typical Uses
HW	...	C 0.35-0.75; Mn 2.00 max; Si 2.50 max; Mo 0.5 max*; Cr 10-14; Ni 58-62; Fe bal	Maximum use temperature: 2050° F in oxidizing, 1900° F in reducing atmospheres. Excellent for severe service at high temperatures involving cyclic heating or thermal shock. Hearths, muffles, retorts, trays, boxes, burner parts, enameling fixtures, quenching fixtures, molten lead containers.
HX	...	Cr 0.35-0.75; Mn 2.00 max; Si 2.50 max; Mo 0.5 max*; Cr 15-19; Ni 64-68; Fe bal	Maximum use temperatures same as HW, but better in resistance to reducing gases containing sulfur at 1800° F. Used in contact with tempering and cyaniding salts. Same applications as HW, improved resistance to hot gas corrosion.

NOTES:

*Molybdenum is not intentionally added to these compositions.

1. Sulfur does not exceed 0.04 per cent in any composition. Except for Type CF-16F, phosphorus does not exceed 0.04 per cent in any composition.
2. Most of the standard grades listed are covered for general applications by American Society for Testing Materials specifications A 296-55 and A 297-55. ASTM specifications A 217-55, A351-58T, A362-52T, B 190-50 and B 207-50 also apply to some of the grades.
3. Cast alloy chemical composition ranges *are not the same* as the wrought alloys. Buyers should use cast alloy designations for proper identification of castings.

FERROUS CASTINGS

DUCTILE (Nodular or Spheroidal Graphite) IRON

Specification	Class or Grade	Tensile Min (psi)	Yield Min (psi)	Elong in 2 in. (min %)	Heat Treatment	Properties and Typical Applications
ASTM A339-55	80-60-03	80,000	60,000	3	.....	High strength in as-cast condition. Heavy duty machinery, gears, dies, rolls.
	60-45-10	60,000	45,000	10	Usually annealed	Toughness and machinability. Pressure castings, valves, pump bodies, compressor heads, shock resisting parts.
ASTM A395-55T	60-45-15	60,000	45,000	15	Ferritized by annealing	Pressure containing parts for use at elevated temperatures. Valves, fittings for steam.
Mil-I-17166A (ships)	60-40-15	60,000	40,000	15	Ferritized by annealing to 190 max BHN	Navy shipboard and other uses requiring shock resistance. Motor frames, ends, engine blocks, heads, compressors, valves, clamps.
ASTM A396-55T	120-90-02	120,000	90,000	2	Heat treated	For high strength applications (obtained by heat treatment), pinions, gears, cams, guides, track rollers.
	100-70-03	100,000	70,000	3		
Mil-I-11466 (ordnance)	Class 1	120,000	90,000	2	Usually quenched and tempered	Military equipment.
	Class 2	100,000	75,000	4		
	Class 3	85,000	60,000	6		
	Class 4	80,000	60,000	3	As-cast	(Unless otherwise specified, one metallographic test shall be made for each lot.)
	Class 5	60,000	45,000	10	Ferritized by annealing	
	Class 6	60,000	40,000	18		

Source: Gray Iron Founders' Society Inc.

MALLEABLE IRON

ASTM Spec. No.	Grade No.	Tensile* Min (psi)	Yield* Min (psi)	Elong. in 2 in. (min %)	Properties and Typical Applications
		STANDARD			
A-47-52	32510	50,000	32,500	10	Tough, impact and fatigue resistant, easily machined, uniform structure. Castable in ⅛-in. minimum sections. Automobile, truck differential cases, carriers, steering gear housings, brackets, railroad car and track parts, agricultural implement parts, conveyor and electrical fittings.
	35018	53,000	35,000	18	
		PEARLITIC			
A-220-55T	45010	65,000	45,000	10	High strength, hardness, resistance to abrasion, good machinability. Has castability and excellent surface finish of standard malleable. Hardenable to 50-60 Rc. Automotive valve rocker arms, automatic transmission parts, agricultural implement gears, sprockets, crankshafts, weapon parts, diesel electric power switch segment gears, armature and frame heads, gear cases, shifter forks.
	45007	65,000	45,000	7	
	48004	70,000	48,000	4	
	50007	75,000	50,000	7	
	53004	80,000	53,000	4	
	60003	80,000	60,000	3	
	80002	100,000	80,000	2	

Source: Malleable Founders' Society.

*Higher tensile and yield strengths may be obtained from any of the pearlitic malleable grades by a conventional quench-and-temper treatment.

CAST STEEL—Carbon Structural Grades

ASTM or SAE Specifications	Class	Tensile Strength (psi)	Yield Strength (psi)	Elong. (%)	Carbon (max %)	Manganese (max %)	Properties and Typical Applications
A-27-58	U-60-30	60,000	30,000	22	0.25	0.75	Low electrical resistivity, excellent weldability. Can be carburized and case hardened. Electrical equipment gears, drums, railroad and furnace equipment.
	60-30	60,000	30,000	24	0.30	0.60	
A-27-58	65-30	65,000	30,000	20			Excellent weldability, medium strength, good durability and machinability. Railroad, power shovel, rolling mill equipment, presses, gears, sprockets, machine frames, miscellaneous medium strength castings.
	65-35	65,000	35,000	24	0.30	0.70	
	70-36	70,000	36,000	22	0.35	0.70	
	70-40	70,000	40,000	22	0.25	1.20	
SAE 080		80,000	40,000	18			High strength, toughness, good fatigue, wear resistance, high rigidity. Gears, rolls, blanking and forming dies, pinions, sprockets, machine tools, impellers, liners, castings requiring rigidity and hardness.
SAE 0050		85,000	45,000	16	0.50	0.90	

CAST STEEL—Low Alloy Engineering Grades

ASTM or SAE Specifications	Class	Tensile Strength (psi)	Yield Strength (psi)	Elong. (%)	Normalized & Tempered†	Water Quenched & Tempered†	Properties and Typical Applications
A148-58	80-40	80,000	40,000	18	1330		Excellent weldability, medium strength with high toughness and good machinability; shock and abrasion resistance. Pneumatic tools, railroad equipment, pressure parts, automotive parts, track wheels, tractor treads, gears, sprockets.
	80-50	80,000	50,000	22	2317		
					4032		
					6120		
					Mn Mo*		
					8130		
A148-58	90-60	90,000	60,000	20	1335	1330	Offers a variety of strengths and hardenabilities depending on alloy content. Good fatigue properties.
SAE 090		90,000	60,000	20	3130	4028	
					4137	5135	
					4630		
					6130		
					Mn Mo*		
					Mn V*		Normalized and Tempered: Oil well tools, sheaves, sprockets, locomotive parts; gears, cams, earth moving equipment, highly stressed parts.
		100,000	65,000	17	3135	4032	
					4140	8130	
					4330	Mn Mo*	Quenched and Tempered: Hardened castings, gears, cams, rollers, abrasion resistant castings, bucket teeth, small crusher jaws, conveyor chain links, dredge pumps, impellers, valve liners, oil field tongs. Good impact properties.
					4635		
					6130		
					Mn Mo*		
					8630		
					4032		
					8130		
A148-58	105-85	105,000	85,000	17	4140	3130	High resistance to impact, excellent strength and toughness.
SAE 0105		105,000	85,000	17	4335	4130	
					9530	4030	
						4630	
						Mn Mo*	Normalized and Tempered: Excellent air hardening properties. Abrasion resistant applications, dredge pumps, gears, dies, rolling mill equipment, molybdenum-bearing castings for shock valves, flanges, turbine casings, hydroelectric equipment.
A148-58	120-95	120,000	95,000	14	4340	3135	
SAE 0120		120,000	100,000	14		6130	
						Mn Mo*	
						8630	
						9530	Quenched and Tempered: Good low temperature impact toughness, excellent abrasion resistance, deep hardening.
						4340	
A148-58	150-125	150,000	125,000	9		4330	Deep hardening, high strength, and high wear resistance.
SAE 0150		150,000	125,000	9		9530	
A148-58	175-145	175,000	145,000	6			
SAE 0175		175,000	145,000	6			

*Mn Mo = C 0.25-0.35, Mn 1.25-1.75, Mo 0.15-0.25.
**MnV = C 0.25-0.35, Mn 1.25-1.75, V 0.10-0.15.

CAST STEEL—High & Low Temperature Service

ASTM or SAE Specifications	Class	Tensile Strength (psi)	Yield Strength (psi)	Elong. (%)	Bend & Impact Properties	Properties and Typical Applications
A 216-58T	WCA	60,000	30,000	24	90 degree bend*	A 216-58T carbon steels exhibit good weldability and good creep resistance at relatively high temperatures. Pressure containing castings for medium high temperature service.
	WCB	70,000	36,000	22	90 degree bend	
A 217-58T	WC1	65,000	35,000	24	90 degree bend	A 217-58T steels are alloyed to give good creep resistance and high temperature properties. Pressure containing castings for high temperature service.
	WC4, WC5	70,000	40,000	20	90 degree bend	
	WC6, WC9					
	C5, C12	90,000	60,000	18	90 degree bend	
A 352-58T	LCB, LC1	65,000	35,000	24	15 ft-lb	Ferritic steels with good notch ductility at temperatures from −50 to −150° F. Test temperatures for each grade: −50° F, LCB; −75° F, LC1; −100° F, LC2; −150° F, LC3. Pressure containing castings for service at low temperatures.
	LC2, LC3	65,000	40,000	24	15 ft-lb	

*Expected value only, no test required unless specified.
**Charpy keyhole notch impact test required at temperatures specified by customer.
†Some of the alloys that meet strength requirements when heat treated as indicated.
Source: Steel Founders' Society of America.

GRAY IRON

Specification	Class	Tensile Min (psi)	Heat Treatment*	Properties and Typical Applications
ASTM A-48-56 ASA G25.1-1948 ASME S61-1948 AASHO M105-49 CSA S61-1948 Federal QQ-1-652a (All basically the same)	20	20,000	2	Same as ASTM A190-47, ASA G27.1-1942 (See Page S-16) with minimum tensile requirement. Excellent machinability as annealed.
	25	25,000		
	30	30,000	1	Good mechanical properties with high machinability. Most commonly used grade for general machinery, valves, light compressor bodies, municipal castings, waterworks equipment.
	35	35,000		
	40	40,000	1	Machine tools, medium gear blanks, heavy compressors, motor blocks.
	45	45,000		
	50	50,000	1	Large castings for heavy service: Dies, hydraulic cylinders, machine tools, permanent molds, large gears, press frames.
	60	60,000		

(Continued on Page S-16)

FERROUS CASTINGS (continued)

Specification		Class	Tensile Min (psi)	Heat Treatment*	Properties and Typical Applications
ASTM A159-55 SAE spec. No. given in class column	Automotive castings	110	20,000	2	Miscellaneous soft iron castings in which strength and microstructure are not primary considerations.
		111	30,000	1	Small cylinder blocks, heads, pistons, clutch plates, oil pump bodies, gearboxes, clutch housings, lightweight brake drums.
		113	30,000	1	Brake drums and clutch plates for moderate service requirements where high-carbon iron is desired and heat checking is problem.
		114	40,000	1	Heavy duty drums and clutch plates where strength and resistance to heat checking are requirements.
		120	35,000	1	Automotive cylinder blocks, heads, flywheels, cylinder liners, pistons.
		121	40,000	1	Truck and tractor cylinder blocks, heads, heavy flywheels, tractor transmission cases, differential carriers.
		122	45,000	1	Diesel engine castings, liners, cylinders, pistons, heavy parts.
ASTM A190-47 ASA G27.1-1942		.. ..	....	2	Lightweight, thin section castings requiring good appearance, high machinability, close tolerances. Use where strength is not a prime requisite. Specific qualities usually established by sample.
ASTM A278-56		40 50 60	40,000 50,000 60,000	3 3 3	Pressure containing parts for use up to 650° F. Valve bodies, paper mill dryer rolls, chemical process equipment.
ASTM A319-53		I II III	Low 30,000 about 40,000	2 2 2	Nonpressure containing parts for elevated temperature. Stoker and firebox parts, grate bars, process furnace parts, ingot molds. I: Superior resistance to thermal shock. II: Average resistance to thermal shock; moderate tensile strength. III: High creep and rupture strength.
U.S. Navy 46-1-9		..	25,000	..	High alloy scale resisting castings. For resistance to corrosion of acid, caustic and salt, including concentrated brine.
Mil-G-858A		I II	25,000 25,000	.. ..	High alloy for resistance to corrosion, scaling, warpage, growth; use at elevated temperatures. Galley range tops; to resist acid, caustic, and salt.

Source: Gray Iron Founders' Society Inc.

*1. Hardenable by conventional, flame, or induction heat treatment. 2. Hardening not recommended. 3. Must be stress relief annealed.

ALLOY STEELS

Standard, Tentative Standard (TS) & Boron Open Hearth & Electric Furnace Steel—Bars, Billets, Blooms, Slabs

SAE or AISI Number	C	Mn	P Max	S Max	Si	Ni	Cr	Mo
1330	0.28–0.33	1.60–1.90	0.040	0.040	0.20–0.35	.....	.....	.....
1335	0.33–0.38	1.60–1.90	0.040	0.040	0.20–0.35	.....	.....	.....
1340	0.38–0.43	1.60–1.90	0.040	0.040	0.20–0.35	.....	.....	.....
1345	0.43–0.48	1.60–1.90	0.040	0.040	0.20–0.35	.....	.....	.....
TS 14B35*	0.33–0.38	0.75–1.00	....	....	0.20–0.35	.....	.....	.....
3140	0.38–0.43	0.70–0.90	0.040	0.040	0.20–0.35	1.10–1.40	0.55–0.75	.....
E3310**	0.08–0.13	0.45–0.60	0.025	0.025	0.20–0.35	3.25–3.75	1.40–1.75	.....
4012	0.09–0.14	0.75–1.00	0.040	0.040	0.20–0.35	.....	.....	0.15–0.25
4023	0.20–0.25	0.70–0.90	0.040	0.040	0.20–0.35	.....	.....	0.20–0.30
4024	0.20–0.25	0.70–0.90	0.040	0.035–0.050	0.20–0.35	.....	.....	0.20–0.30
4027	0.25–0.30	0.70–0.90	0.040	0.040	0.20–0.35	.....	.....	0.20–0.30
4028	0.25–0.30	0.70–0.90	0.040	0.035–0.050	0.20–0.35	.....	.....	0.20–0.30
4037	0.35–0.40	0.70–0.90	0.040	0.040	0.20–0.35	.....	.....	0.20–0.30
4042	0.40–0.45	0.70–0.90	0.040	0.040	0.20–0.35	.....	.....	0.20–0.30
4047	0.45–0.50	0.70–0.90	0.040	0.040	0.20–0.35	.....	.....	0.20–0.30
4063	0.60–0.67	0.75–1.00	0.040	0.040	0.20–0.35	.....	.....	0.20–0.30
4118	0.18–0.23	0.70–0.90	0.040	0.040	0.20–0.35	.....	0.40–0.60	0.08–0.15
4130	0.28–0.33	0.40–0.60	0.040	0.040	0.20–0.35	.....	0.80–1.10	0.15–0.25
4135	0.33–0.38	0.70–0.90	0.040	0.040	0.20–0.35	.....	0.80–1.10	0.15–0.25
4137	0.35–0.40	0.70–0.90	0.040	0.040	0.20–0.35	.....	0.80–1.10	0.15–0.25
4140	0.38–0.43	0.75–1.00	0.040	0.040	0.20–0.35	.....	0.80–1.10	0.15–0.25
TS 4140*	0.38–0.43	0.80–1.05	....	....	0.20–0.35	.....	0.90–1.20	0.08–0.15
4142	0.40–0.45	0.75–1.00	0.040	0.040	0.20–0.35	.....	0.80–1.10	0.15–0.25
4145	0.43–0.48	0.75–1.00	0.040	0.040	0.20–0.35	.....	0.80–1.10	0.15–0.25
4147	0.45–0.50	0.75–1.00	0.040	0.040	0.20–0.35	.....	0.80–1.10	0.15–0.25
4150	0.48–0.53	0.75–1.00	0.040	0.040	0.20–0.35	.....	0.80–1.10	0.15–0.25
TS 4150*	0.48–0.53	0.80–1.05	....	....	0.20–0.35	.....	0.90–1.20	0.08–0.15
4320	0.17–0.22	0.45–0.65	0.040	0.040	0.20–0.35	1.65–2.00	0.40–0.60	0.20–0.30
4337	0.35–0.40	0.60–0.80	0.040	0.040	0.20–0.35	1.65–2.00	0.70–0.90	0.20–0.30
E4337*	0.35–0.40	0.65–0.85	0.025	0.025	0.20–0.35	1.65–2.00	0.70–0.90	0.20–0.30
4340	0.38–0.43	0.60–0.80	0.040	0.040	0.20–0.35	1.65–2.00	0.70–0.90	0.20–0.30
E4340	0.38–0.43	0.65–0.85	0.025	0.025	0.20–0.35	1.65–2.00	0.70–0.90	0.20–0.30
4422	0.20–0.25	0.70–0.90	0.040	0.040	0.20–0.35	.....	.....	0.35–0.45
4427	0.24–0.29	0.70–0.90	0.040	0.040	0.20–0.35	.....	.....	0.35–0.45
4520	0.18–0.23	0.45–0.65	0.040	0.040	0.20–0.35	.....	.....	0.45–0.60
4615	0.13–0.18	0.45–0.65	0.040	0.040	0.20–0.35	1.65–2.00	.....	0.20–0.30
4617	0.15–0.20	0.45–0.65	0.040	0.040	0.20–0.35	1.65–2.00	.....	0.20–0.30
4620	0.17–0.22	0.45–0.65	0.040	0.040	0.20–0.35	1.65–2.00	.....	0.20–0.30

SAE or AISI Number	C	Mn	P Max	S Max	Si	Ni	Cr	Mo
4621	0.18–0.23	0.70–0.90	0.040	0.040	0.20–0.35	1.65–2.00	.....	0.20–0.30
4718	0.16–0.21	0.70–0.90	0.040	0.040	0.20–0.35	0.90–1.20	0.35–0.55	0.30–0.40
4720	0.17–0.22	0.50–0.90	0.040	0.040	0.20–0.35	0.90–1.20	0.35–0.55	0.15–0.25
4815	0.13–0.18	0.40–0.60	0.040	0.040	0.20–0.35	3.25–3.75	.....	0.20–0.30
4817	0.15–0.20	0.40–0.60	0.040	0.040	0.20–0.35	3.25–3.75	.....	0.20–0.30
4820	0.18–0.23	0.50–0.70	0.040	0.040	0.20–0.35	3.25–3.75	.....	0.20–0.30
5015	0.12–0.17	0.30–0.50	0.040	0.040	0.20–0.35	.....	0.30–0.50	.....
50B40	0.38–0.43	0.75–1.00	0.040	0.040	0.20–0.35	.....	0.40–0.60	.....
50B44	0.43–0.48	0.75–1.00	0.040	0.040	0.20–0.35	.....	0.40–0.60	.....
5046	0.43–0.50	0.75–1.00	0.040	0.040	0.20–0.35	.....	0.20–0.35	.....
50B46	0.43–0.50	0.75–1.00	0.040	0.040	0.20–0.35	.....	0.20–0.35	.....
50B50	0.48–0.53	0.75–1.00	0.040	0.040	0.20–0.35	.....	0.40–0.60	.....
50B60	0.55–0.65	0.75–1.00	0.040	0.040	0.20–0.35	.....	0.40–0.60	.....
5115	0.13–0.18	0.70–0.90	0.040	0.040	0.20–0.35	.....	0.70–0.90	.....
5120	0.17–0.22	0.70–0.90	0.040	0.040	0.20–0.35	.....	0.70–0.90	.....
5130	0.28–0.33	0.70–0.90	0.040	0.040	0.20–0.35	.....	0.80–1.10	.....
5132	0.30–0.35	0.60–0.80	0.040	0.040	0.20–0.35	.....	0.75–1.00	.....
5135	0.33–0.38	0.60–0.80	0.040	0.040	0.20–0.35	.....	0.80–1.05	.....
5140	0.38–0.43	0.70–0.90	0.040	0.040	0.20–0.35	.....	0.70–0.90	.....
5145	0.43–0.48	0.70–0.90	0.040	0.040	0.20–0.35	.....	0.70–0.90	.....
5147	0.45–0.52	0.70–0.95	0.040	0.040	0.20–0.35	.....	0.85–1.15	.....
5150	0.48–0.53	0.70–0.90	0.040	0.040	0.20–0.35	.....	0.70–0.90	.....
5155	0.50–0.60	0.70–0.90	0.040	0.040	0.20–0.35	.....	0.70–0.90	.....
5160	0.55–0.65	0.75–1.00	0.040	0.040	0.20–0.35	.....	0.70–0.90	.....
51B60	0.55–0.65	0.75–1.00	0.040	0.040	0.20–0.35	.....	0.70–0.90	.....
E50100**	0.95–1.10	0.25–0.45	0.025	0.025	0.20–0.35	.....	0.40–0.60	.....
E51100**	0.95–1.10	0.25–0.45	0.025	0.025	0.20–0.35	.....	0.90–1.15	.....
E52100**	0.95–1.10	0.25–0.45	0.025	0.025	0.20–0.35	.....	1.30–1.60	.....
								V
6118	0.16–0.21	0.50–0.70	0.040	0.040	0.20–0.35	.....	0.50–0.70	0.10–0.15
6120	0.17–0.22	0.70–0.90	0.040	0.040	0.20–0.35	.....	0.70–0.90	0.10 min
6150	0.48–0.53	0.70–0.90	0.040	0.040	0.20–0.35	.....	0.80–1.10	0.15 min
								Mo
3115	0.13–0.18	0.70–0.90	0.040	0.040	0.20–0.35	0.20–0.40	0.30–0.50	0.08–0.15
81B45	0.43–0.48	0.75–1.00	0.040	0.040	0.20–0.35	0.20–0.40	0.35–0.55	0.08–0.15
8615	0.13–0.18	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25
8617	0.15–0.20	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25
8620	0.18–0.23	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25
8622	0.20–0.25	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25
8625	0.23–0.28	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25
8627	0.25–0.30	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25
8630	0.28–0.33	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25
8637	0.35–0.40	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25
8640	0.38–0.43	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25
8642	0.40–0.45	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25
8645	0.43–0.48	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25
86B45	0.43–0.48	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25
8650	0.48–0.53	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25
8655	0.50–0.60	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25
8660	0.55–0.65	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25
8720	0.18–0.23	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.20–0.30
8735*	0.33–0.38	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.20–0.30
8740	0.38–0.43	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.20–0.30
8742	0.40–0.45	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.20–0.30
8822	0.20–0.25	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.30–0.40
9255	0.50–0.60	0.70–0.95	0.040	0.040	1.80–2.20	.....	.....	.....
9260	0.55–0.65	0.70–1.00	0.040	0.040	1.80–2.20	.....	.....	.....
9262	0.55–0.65	0.75–1.00	0.040	0.040	1.80–2.20	.....	0.25–0.40	.....
E9310**	0.08–0.13	0.45–0.65	0.025	0.025	0.20–0.35	3.00–3.50	1.00–1.40	0.08–0.15
94B15	0.13–0.18	0.75–1.00	0.040	0.040	0.20–0.35	0.30–0.60	0.30–0.50	0.08–0.15
94B17	0.15–0.20	0.75–1.00	0.040	0.040	0.20–0.35	0.30–0.60	0.30–0.50	0.08–0.15
94B30	0.28–0.33	0.75–1.00	0.040	0.040	0.20–0.35	0.30–0.60	0.30–0.50	0.08–0.15
94B40	0.38–0.43	0.75–1.00	0.040	0.040	0.20–0.35	0.30–0.60	0.30–0.50	0.08–0.15
9840	0.38–0.43	0.70–0.90	0.040	0.040	0.20–0.35	0.85–1.15	0.70–0.90	0.20–0.30
9850	0.48–0.53	0.70–0.90	0.040	0.040	0.20–0.35	0.85–1.15	0.70–0.90	0.20–0.30
								Al
Standard Nitriding Steel	0.38–0.43	0.50–0.70	0.040	0.040	0.20–0.40	0.95–1.30	1.40–1.80	0.30–0.40

Source—American Iron & Steel Institute, 1957.

*No corresponding SAE number.

**SAE numbers do not have prefix E.

NOTES

1. TS denotes tentative standard steels.
2. Boron steels indicated by B can be expected to have 0.0005 per cent minimum boron content.
3. Grades with prefix E are manufactured by basic electric furnace process. All others are normally produced by basic open hearth process but may be made by basic electric furnace process with adjustments in phosphorus and sulfur.
4. Ranges and limits apply to steel not exceeding 200 sq in. cross-sectional area.
5. All chemical ranges and limits are subject to standard variations for check analysis over or under specification.
6. Phosphorus and sulfur limitations for each process:

Basic electric furnace	0.025% max
Basic open hearth	0.040% max
Acid electric furnace	0.050% max
Acid open hearth	0.050% max

7. Minimum silicon limit for acid open hearth or acid electric furnace alloy steel is 0.15 per cent.
8. Small quantities of certain elements in alloy steel are not specified or required. They are considered as incidental and may be present in these maximum amounts: Copper, 0.35%; nickel, 0.25; chromium, 0.20; molybdenum, 0.06.
9. Where sulfur content range is shown, it is indicative of resulfurized steel.

H-STEELS

Standard, Tentative Standard (TS) & Boron Open Hearth & Electric Furnace Steels—Bars, Billets, Blooms

SAE or AISI NUMBER	C	Mn	Si	Ni	Cr	Mo
1330-H	0.27–0.33	1.45–2.05	0.20–0.35	.....	.....	.....
1335-H	0.32–0.38	1.45–2.05	0.20–0.35	.....	.....	.....
1340-H	0.37–0.44	1.45–2.05	0.20–0.35	.....	.....	.....
TS 14B35-H	0.32–0.38	0.65–1.10	0.20–0.35	.....	.....	.....
3140-H	0.37–0.44	0.60–1.00	0.20–0.35	1.00–1.45	0.45–0.85	.....
3310-H	0.07–0.13	0.30–0.70	0.20–0.35	3.20–3.80	1.30–1.80	.....
4027-H	0.24–0.30	0.60–1.00	0.20–0.35	.....	.....	0.20–0.30
4028-H*	0.24–0.30	0.60–1.00	0.20–0.35	.....	.....	0.20–0.30
4037-H	0.34–0.41	0.60–1.00	0.20–0.35	.....	.....	0.20–0.30
4042-H	0.39–0.46	0.60–1.00	0.20–0.35	.....	.....	0.20–0.30
4047-H	0.44–0.51	0.60–1.00	0.20–0.35	.....	.....	0.20–0.30
4063-H	0.59–0.69	0.65–1.10	0.20–0.35	.....	.....	0.20–0.30
4118-H	0.17–0.23	0.60-1.00	0.20–0.35	.....	0.30–0.70	0.08–0.15
4130-H	0.27–0.33	0.30–0.70	0.20–0.35	.....	0.75–1.20	0.15–0.25
4135-H	0.32–0.38	0.60–1.00	0.20–0.35	.....	0.75–1.20	0.15–0.25
4137-H	0.34–0.41	0.60–1.00	0.20–0.35	.....	0.75–1.20	0.15–0.25
4140-H	0.37–0.44	0.65–1.10	0.20–0.35	.....	0.75–1.20	0.15–0.25
TS 4140-H	0.37–0.44	0.70–1.20	0.20–0.35	.....	0.85–1.30	0.08–0.15
4142-H	0.39–0.46	0.65–1.10	0.20–0.35	.....	0.75–1.20	0.15–0.25
4145-H	0.42–0.49	0.65–1.10	0.20–0.35	.....	0.75–1.20	0.15–0.25
4147-H	0.44–0.51	0.65–1.10	0.20–0.35	.....	0.75–1.20	0.15–0.25
4150-H	0.47–0.54	0.65–1.10	0.20–0.35	.....	0.75–1.20	0.15–0.25
TS 4150-H	0.47–0.54	0.70–1.20	0.20–0.35	.....	0.85–1.30	0.08–0.15
4320-H	0.17–0.23	0.40–0.70	0.20–0.35	1.55–2.00	0.35–0.65	0.20–0.30
4337-H	0.34–0.41	0.55–0.90	0.20–0.35	1.55–2.00	0.65–0.95	0.20–0.30
4340-H	0.37–0.44	0.55–0.90	0.20–0.35	1.55–2.00	0.65–0.95	0.20–0.30
E4340-H	0.37–0.44	0.60–0.95	0.20–0.35	1.55–2.00	0.65–0.95	0.20–0.30
4620-H	0.17–0.23	0.35–0.75	0.20–0.35	1.55–2.00	.....	0.20–0.30
4621-H	0.17–0.23	0.60–1.00	0.20–0.35	1.55–2.00	.....	0.20–0.30
4720-H	0.17–0.23	0.45–0.75	0.20–0.35	0.85–1.25	0.30–0.60	0.15–0.25
4815-H	0.12–0.18	0.30–0.70	0.20–0.35	3.20–3.80	.....	0.20–0.30
4817-H	0.14–0.20	0.30–0.70	0.20–0.35	3.20–3.80	.....	0.20–0.30
4820-H	0.17–0.23	0.40–0.80	0.20–0.35	3.20–3.80	.....	0.20–0.30
5046-H	0.43–0.50	0.65–1.10	0.20–0.35	.....	0.13–0.43	.....
50B40-H	0.37–0.44	0.65–1.10	0.20–0.35	.....	0.30–0.70	.....
50B44-H	0.42–0.49	0.65–1.10	0.20–0.35	.....	0.30–0.70	.....
50B46-H	0.43–0.50	0.65–1.10	0.20–0.35	.....	0.13–0.43	.....
50B50-H	0.47–0.54	0.65–1.10	0.20–0.35	.....	0.30–0.70	.....
50B60-H	0.55–0.65	0.65–1.10	0.20–0.35	.....	0.30–0.70	.....
5120-H	0.17–0.23	0.60–1.00	0.20–0.35	.....	0.60–1.00	.....
5130-H	0.27–0.33	0.60–1.00	0.20–0.35	.....	0.75–1.20	.....
5132-H	0.29–0.35	0.50–0.90	0.20–0.35	.....	0.65–1.10	.....
5135-H	0.32–0.38	0.50–0.90	0.20–0.35	.....	0.70–1.15	.....
5140-H	0.37–0.44	0.60–1.00	0.20–0.35	.....	0.60–1.00	.....
5145-H	0.42–0.49	0.60–1.00	0.20–0.35	.....	0.60–1.00	.....
5147-H	0.45–0.52	0.60–1.05	0.20–0.35	.....	0.80–1.25	.....
5150-H	0.47–0.54	0.60–1.00	0.20–0.35	.....	0.60–1.00	.....
5155-H	0.50–0.60	0.60–1.00	0.20–0.35	.....	0.60–1.00	.....
5160-H	0.55–0.65	0.65–1.10	0.20–0.35	.....	0.60–1.00	.....
51B60-H	0.55–0.65	0.65–1.10	0.20–0.35	.....	0.60–1.00	V
6120-H	0.17–0.23	0.60–1.00	0.20–0.35	.....	0.60–1.00	0.10 min
6150-H	0.47–0.54	0.60–1.00	0.20–0.35	.....	0.75–1.20	0.15 min
						Mo
81B45-H	0.42–0.49	0.70–1.05	0.20–0.35	0.15–0.45	0.30–0.60	0.08–0.15
8617-H	0.14–0.20	0.60–0.95	0.20–0.35	0.35–0.75	0.35–0.65	0.15–0.25
8620-H	0.17–0.23	0.60–0.95	0.20–0.35	0.35–0.75	0.35–0.65	0.15–0.25
8622-H	0.19–0.25	0.60–0.95	0.20–0.35	0.35–0.75	0.35–0.65	0.15–0.25
8625-H	0.22–0.28	0.60–0.95	0.20–0.35	0.35–0.75	0.35–0.65	0.15–0.25
8627-H	0.24–0.30	0.60–0.95	0.20–0.35	0.35–0.75	0.35–0.65	0.15–0.25
8630-H	0.27–0.33	0.60–0.95	0.20–0.35	0.35–0.75	0.35–0.65	0.15–0.25
8637-H	0.34–0.41	0.70–1.05	0.20–0.35	0.35–0.75	0.35–0.65	0.15–0.25
8640-H	0.37–0.44	0.70–1.05	0.20–0.35	0.35–0.75	0.35–0.65	0.15–0.25
8642-H	0.39–0.46	0.70–1.05	0.20–0.35	0.35–0.75	0.35–0.65	0.15–0.25
8645-H	0.42–0.49	0.70–1.05	0.20–0.35	0.35–0.75	0.35–0.65	0.15–0.25
86B45-H	0.42–0.49	0.70–1.05	0.20–0.35	0.35–0.75	0.35–0.65	0.15–0.25
8650-H	0.47–0.54	0.70–1.05	0.20–0.35	0.35–0.75	0.35–0.65	0.15–0.25
8655-H	0.50–0.60	0.70–1.05	0.20–0.35	0.35–0.75	0.35–0.65	0.15–0.25
8660-H	0.55–0.65	0.70–1.05	0.20–0.35	0.35–0.75	0.35–0.65	0.15–0.25
8720-H	0.17–0.23	0.60–0.95	0.20–0.35	0.35–0.75	0.35–0.65	0.20–0.30
8740-H	0.37–0.44	0.70–1.05	0.20–0.35	0.35–0.75	0.35–0.65	0.20–0.30
8742-H	0.39–0.46	0.70–1.05	0.20–0.35	0.35–0.75	0.35–0.65	0.20–0.30
8822-H	0.19–0.25	0.70–1.05	0.20–0.35	0.35–0.75	0.35–0.65	0.30–0.40
9260-H	0.55–0.65	0.65–1.10	1.70–2.20	.....	.....	.....
9262-H	0.55–0.65	0.65–1.10	1.70–2.20	.....	0.20–0.50	.....
9310-H	0.07–0.13	0.40–0.70	0.20–0.35	2.95–3.55	1.00–1.45	0.08–0.15
94B15-H	0.12–0.18	0.70–1.05	0.20–0.35	0.25–0.65	0.25–0.55	0.08–0.15
94B17-H	0.14–0.20	0.70–1.05	0.20–0.35	0.25–0.65	0.25–0.55	0.08–0.15
94B30-H	0.27–0.33	0.70–1.05	0.20–0.35	0.25–0.65	0.25–0.55	0.08–0.15
94B40-H	0.37–0.44	0.70–1.05	0.20–0.35	0.25–0.65	0.25–0.55	0.08–0.15
9840-H	0.37–0.44	0.60–0.95	0.20–0.35	0.80–1.20	0.65–0.95	0.20–0.30
9850-H	0.47–0.54	0.60–0.95	0.20–0.35	0.80–1.20	0.65–0.95	0.20–0.30

NOTES
1. TS denotes tentative standard steels.
2. Boron steels indicated by B can be expected to have 0.0005% min boron content.
3. Notes 4, 5, 6, 7, and 8 on Alloy Steels apply to H-Steels.

Source: American Iron & Steel Institute, 1958.
*Sulfur content 0.035-0.050%.

SPRING ALLOYS

Name or Trademark and Specification	Nominal Composition %*	Properties and Typical Uses
HIGH CARBON		
Music Wire ASTM A228-51 AMS-5112	C 0.70-1.00; Mn 0.20-0.60	Widely used for small springs. High tensile strength; stands high stresses. Temperature limit: 250° F. Torsion working stress 90,000-180,000 psi; bending working stress 150,000-350,000 psi.
MB Grade Oil Tempered ASTM A229-56	C 0.55-0.75; Mn 0.60-1.20	General purpose steel for coil springs where cost of music wire is prohibitive, or in larger sizes than available in music wire. Not recommended for shock, impact loading, or use above 350° F. Torsion working stress 80,000-130,000 psi; bending working stress 120,000-250,000 psi.
MB Grade Hard Drawn ASTM A227-47	C 0.45-0.75; Mn 0.60-1.20	Cheapest spring steel for general purposes. Used where accuracy of loads and deflections not important. Temperature limit: 250° F. Torsion working stress 75,000-130,000 psi; bending working stress 100,000-200,000 psi.
MB Grade Soft or Untempered	C 0.55-0.75; Mn 0.60-1.20	Used in helical springs or wire forms where severe forming is required. May be obtained dead soft (annealed at final size) or with one or more draws after heat treatment. Hardened and tempered after fabrication.
HB Grade Soft, Hard Drawn, or Oil Tempered	C 0.71-0.85; Mn 0.60-0.90	Uses similar to MB grade. Tensile strengths higher than MB grade, but in the hard drawn condition are lower than music wire. Uses are about halfway between the two.
Extra HB Grade Soft or Oil Tempered	C 0.86-1.05; Mn 0.30-0.60	Applications same as HB grade.
Upholstery Grade ASTM A407-57T	C 0.45-0.70; Mn 0.60-1.20	Not suitable for precision springs. Used where loads and fatigue life are not a factor. Examples: Wire forms and hooks, mattress and upholstery springs.
FLAT HIGH CARBON		
Cold Rolled Flat Spring Steel, Hard Rolled or Annealed	C 0.48-0.65; Mn 0.60-0.90	Used for miscellaneous springs and washers. In annealed condition will withstand more severe deformation than the 0.65-0.80 carbon grade.
Cold Rolled Spring Steel, Tempered or Annealed	C 0.65-0.80; Mn 0.30-0.90	Most popular flat, cold rolled spring steel. Used for spring clips, flat springs, motor power, spiral springs.
Cold Rolled Spring Steel, Tempered or Annealed	C 0.90-1.05; Mn 0.30-0.50	Used principally for clock and motor springs. Can withstand higher stress than the 0.65-0.80 carbon grade. Used for instrument and flat springs that have limited forming requirements.
ALLOY STEELS		
Chromium AISI 5155 SAE 5155	C 0.50-0.60; Mn 0.70-0.90; Si 0.20-0.35; Cr 0.70-0.90	Automotive type leaf springs.
Chromium AISI 5160 SAE 5160	C 0.55-0.65; Mn 0.75-1.00; Si 0.20-0.35; Cr 0.70-0.90	Automotive type coil springs.
Chrome-Vanadium ASTM A60-49	C 0.48-0.53; Mn 0.70-0.90; Cr 0.80-1.10; Si 0.20-0.35; V 0.15 min	Hot rolled, chromium-vanadium steel bars used in the manufacture of springs.
Chrome-Vanadium ASTM A231-41 **SAE 6150**	C 0.45-0.55; Mn 0.60-0.90; Cr 0.80-1.10; Si 0.15-0.30; V 0.15 (0.18 desired)	Good for shock, impact loading, and temperatures to 425° F. Torsion working stress 100,000-130,000 psi; bending working stress 180,000-230,000 psi.
Silicon-Manganese ASTM A59-49 SAE 9260	C 0.55-0.65; Mn 0.70-1.00; Si 1.80-2.20	Used in flat leaf springs for trucks and as a substitute for more expensive steels. Not recommended in pretempered wire.
Chrome-Silicon ASTM A401-58 SAE 9254	C 0.50-0.60; Mn 0.50-0.80; Si 1.20-1.60; Cr 0.50-0.80	For highly stressed springs requiring long life that are subject to shock loading, such as recoil springs on guns. Can be heat treated to Rc 50-53. May be used up to 475° F. Torsion working stress 115,000-150,000 psi; bending working stress 190,000-240,000 psi.
Chrome-Moly-Nickel AISI 8650 ASTM A332-56 Grade 8650	C 0.48-0.53; Mn 0.75-1.00; Si 0.20-0.35; Ni 0.40-0.70; Cr 0.40-0.60; Mo 0.15-0.25	Developed as an alternate for chrome-vanadium SAE 6150. Used in large sections for hot formed springs in railroad cars.
Chrome-Moly-Nickel AISI 8655 ASTM A332-56 Grade 8655	C 0.50-0.60; Mn 0.75-1.00; Si 0.20-0.35; Ni 0.40-0.70; Cr 0.40-0.60; Mo 0.15-0.25	Uses same as for AISI 8650.
Chrome-Moly-Nickel AISI 8660 ASTM A332-56 Grade 8660	C 0.55-0.65; Mn 0.75-1.00; Si 0.20-0.35; Cr 0.40-0.60; Ni 0.40-0.70; Mo 0.15-0.25	Uses same as for AISI 8650.
VALVE SPRING STEELS		
High Carbon Valve Spring Wire ASTM A230-47	C 0.60-0.75; Mn 0.50-0.90; Si 0.12-0.30	Valve springs in automotive and aircraft engines and other springs requiring high fatigue properties. Uniform properties, smooth finish, and tensile strengths of 195,000-250,000 psi.
Chrome-Vanadium Valve Spring Wire ASTM A232-47 AMS-6450	C 0.45-0.55; Mn 0.60-0.90; Si 0.12-0.30; Cr 0.80-1.10; V 0.15-0.25	Automotive and aircraft valve springs. Stands high stresses, shock and impact loading up to 400° F, with long fatigue life.
STAINLESS STEELS		
Types 301 and 302	Ni 7.00-10.00; Cr 17.00-19.00; C 0.15 max	Furnished in reasonably high tensile strength with lower permeability than carbon steels. Magnetic when worked to spring temper. General purpose corrosion resistance uses. Can be used to 550° F. Torsion working stress 45,000-140,000 psi; bending working stress 60,000-260,000 psi.
Type 316	Ni 10.00-14.00; Cr 16.00-18.00; Mo 2.00-3.00; Mn 2.00; C 0.08 max	Addition of Mo increases corrosion resistance to most chemicals, particularly the halogens. Lower tensile than 302 for similar amounts of cold reduction. Torsion working stress 40,000-120,000 psi; bending working stress 55,000-220,000 psi.
17-7 PH	Ni 7.00; Cr 17.00; C 0.07; Al 1.00	Good corrosion resistance. Can be used up to 700° F. Torsion working stress 134,000-160,000 psi; bending working stress 195,000-225,000 psi.
PH 15-7 Mo	Ni 7.00; Cr 15.00; Mo 2.25; C 0.066; Al 1.10	
Types 410 and 420	Cr 12.00-14.00	Only used for springs in the heat treated condition. Hardened after forming. Not corrosion resistant unless polished.

(Continued on Page S-20)

SPRING ALLOYS (continued)

Name or Trademark and Specification	Nominal Composition %*	Properties and Typical Uses
COPPER-BASE ALLOYS		
Electrolytic Tough Pitch	Cu 99.90	Has best electrical conductivity of copper and copper-base alloys supplied in spring temper. Used in radio parts and electrical switches.
Gilding, 95%	Cu 95.00; Zn 5.00	Rolled strip supplied in spring temper.
Commercial Bronze, 90% Jewelry Bronze, 87.50% Red Brass, 85% Low Brass, 80%	Cu 90.00; Zn 5.00 Cu 87.50; Zn 12.50 Cu 85.00; Zn 15.00 Cu 80.00; Zn 20.00	Flat products and wire supplied in spring temper. Tensile strength increases and conductivity is slightly reduced with lower copper content.
Cartridge Brass, 70% ASTM B134-51 SAE 80	Cu 70.00; Zn 30.00	A hard-drawn material usually used in the spring-hard temper. Inexpensive, high electrical conductivity, low tensile strength. Used in flat stampings where sharp bends are needed.
Yellow Brass	Cu 65.00; Zn 35.00	Flat products and wire supplied in spring temper.
Phosphor Bronze, 5% (A)	Cu 94.00; Sn 3.50-5.80; P 0.03-0.35	Combines good strength, hardness, electrical conductivity, and corrosion resistance with low cost. Used for contact fingers in switches.
Phosphor Bronze, 8% (C)	Cu 92.00; Sn 7.00-9.00; P 0.03-0.35	Used for more severe service than the 5% alloy. Typical uses: Cotter pins, diaphragms, fuse clips, switch parts, wire brushes.
Phosphor Bronze, 10% (D)	Cu 90.00; Sn 9.00-11.00; P 0.03-0.35	Heavy bars and plates for severe compression, good wear, and corrosion resistance. Used for parts requiring extra spring qualities, greater resiliency, particularly in fatigue.
Nickel Silver, 55-18	Cu 55.00; Ni 18.00; Zn 27.00	The nickel silver alloys have a silvery white color that harmonizes with surroundings. Used for contact fingers. Good electrical conductivity, corrosion resistance.
Nickel Silver, 65-10	Cu 65.00; Ni 10.00; Zn 25.00	Better electrical conductivity than the 55-18 grade. Spring temper supplied in wire only.
Beryllium Copper ASTM B194-55 (flat springs) ASTM B196-52 (round sections)	Cu 98.00; Be 2.00	Electrical switches and components. Can be formed in annealed condition and precipitation hardened to get high tensile strength.
High-Silicon Bronze (A) ASTM B97	Cu 94.80; Si 2.80-3.50; can have small amounts of Fe, Zn, Mn, or Ni	Silicon bronze has excellent resistance to corrosion.
NICKEL-BASE ALLOYS		
Monel Alloy QQ N-281a Cl. A MIL-N-894 C (Cl. A)	Ni 67.00; Cu 30.00	Resists sea water corrosion, is nearly nonmagnetic. Often used in food and beverage equipment. Torsion working stress 50,000-63,000 psi; bending working stress 88,000-107,000 psi. Temperature range: —100 to 400° F.
"K" Monel Alloy QQ-N-286a MIL-W-4471 (Comp. A) MIL-N-17506A (Cl. A)	Ni 63.00-70.00; Al 2.00-4.00; Ti 0.25-1.00; Cu bal	A precipitation hardening alloy. Age hardening gives a higher tensile strength than Monel. Nonmagnetic and can be used at temperatures of —100 to 450° F at working stresses under 45,000 psi. Torsion working stress 60,000-70,000 psi; bending working stress 110,000-120,000 psi.
Inconel Alloy QQ-W-390a	Ni 72.00 min; Cr 14.00-17.00; Fe 6.00-10.00	Nonmagnetic, good corrosion resistance, stands temperatures up to 650° F. Useful at subzero temperatures. Used in steam valves, regulating valves, springs in boilers, compressors, turbines, jet engines. Torsion working stress 55,000-80,000 psi; bending working stress 110,000-135,000 psi.
Inconel "X" Alloy AMS-5698 AMS-5699	Ni 70.00 min; Cr 14.00-17.00; Fe 5.00-9.00; Ti 2.00-2.50; Al 0.40-1.00; Cb 0.70-1.20	A precipitation hardening alloy. Nonmagnetic and can be used in larger sections than Inconel at higher tensile strengths. May be used up to 1100° F, depending on design stresses. Useful at subzero temperatures. Torsion working stress 55,000-85,000 psi; bending working stress 110,000-135,000 psi.
COBALT-BASE ALLOYS		
Elgiloy S J Alloy Durapower Cobenium	Co 40.00; Cr 20.00; Ni 15.00; Mo 7.00; Mg 2.00; C 0.15; Be 0.04; Fe bal	Used for power, compression, extension, torsion and leaf springs. Fatigue and set resistant. High corrosion resistance, nonmagnetic, low hysteresis and drift. Torsion working stress 125,000 psi; bending working stress 250,000 psi. For applications from —85 to 700° F.
Dynavar Dynamet	Ni 13.00; Fe 17.00; Cr 2.00; Co 42.00; W 2.50	Suitable for subzero and up to 750° F temperatures, provided torsional stresses are kept under 75,000 psi. Used in watches and instruments for springs and diaphragms.
S 816	Co 43.00; Ni 20.00; Cr 20.00; Mo 4.00; W 4.00; Cb 4.00; Fe 3.00	Similar to Dynavar and 17-7 PH with better high temperature properties. Used for instrument and watch springs.
Haynes Alloy No. 25	Co 51.50; W 15.00; Ni 10.00; Cr 20.00; Fe 3.00 max	Useful for springs operating at temperatures of 600 to 900° F.
CONSTANT MODULUS ALLOYS		
Ni-Span-C Elinvar Extra	Ni 41.00-43.00; Cr 4.90-5.50; Ti 2.10-2.50; Fe bal	Precipitation hardening alloy. Excellent thermoelastic characteristics over the range of —50 to 150° F. Torsion working stress 60,000 psi; bending working stress 15,000-110,000 psi. Used in control, timing, and measuring equipment.
Iso-Elastic	Ni 35.00-37.00; Cr 7.00-7.60; Mo 0.35-0.70; Fe bal	Used principally in dynamometers, instruments, and food weighing scales. Its temperature compensating characteristics meet requirements of national and state boards of weights and measures. Torsion working stress 40,000-60,000 psi; bending working stress 90,000-100,000 psi.

*Only major elements listed.

MAGNESIUM

Alloys ASTM No.	Nominal Composition % (magnesium is rem.)	Properties
SAND AND PERMANENT MOLD CASTINGS		
AZ63A	Al 6.0; Zn 3.0; Mn 0.15	Maximum toughness or ductility plus moderately high yield strength. Used in heat treated and aged condition.
AZ81A AZ91C	Al 7.6; Zn 1.0; Mn 0.20 Al 8.7; Zn 0.7; Mn 0.20	High ductility plus yield strength comparable to AZ63A-T4. Used in heat treated condition. Properties intermediate between AZ63A and AZ92A. Used in heat treated and aged condition.
AZ92A	Al 9.0; Zn 2.0; Mn 0.15	Maximum yield strength plus good pressure tightness. Used in heat treated and aged condition.
AM100A	Al 10.0; Mn 0.15	Similar to AZ92A. Permanent mold casting mostly. Used in heat treated and aged condition.

Alloys ASTM No.	Nominal Composition % (magnesium is rem.)	Properties
ZE41A	Zn 4.0; R.E. 1.2; Zr 0.7	Good strength and castability. Used in aged condition.
ZK51A	Zn 4.6; Zr 0.7	High ductility plus yield strength. Used in aged condition.
ZK61A	Zn 5.7; Zr 0.7	Higher yield strength than ZK51A. Used in heat treated and aged condition.
ZH62A	Zn 5.7; Th 1.8; Zr 0.7	High ductility and yield strength. Good creep properties to 350° F. Used in aged condition.
QE22A	Ag 2.5; Di 2.0; Zr 0.7	High yield strength and good creep properties to 350° F. Used in heat treated, quenched, and aged condition.
EK31XA	Di 3.2; Zr 0.6	High yield strength and good creep properties to 500° F. Used in heat treated, quenched, and aged condition.
EK30A	R.E. 3.0; Zr 0.35	For elevated temperatures (350-500° F). Used in heat treated and aged condition.
EK41A	R.E. 4.0; Zr 0.6	For elevated temperatures (350-500° F). Used in heat treated and aged condition.
EZ33A	R.E. 3.0; Zn 2.7; Zr 0.7	For elevated temperatures (350-500° F). Used in aged condition.
HK31A	Th 3.0; Zr 0.7	For elevated temperatures (500-700° F). Used in heat treated and aged condition.
HZ32A	Th 3.0; Zn 2.1; Zr 0.7	For elevated temperatures (500-700° F). Used in aged condition.
K1A	Zr 0.7	High damping properties.
DIECASTINGS		
AZ91A	Al 9.0; Zn 0.7; Mn 0.20; Cu 0.10 max	Specification grade. Good strength, ductility, and castability.
AZ91B	Al 9.0; Zn 0.7; Mn 0.20; Cu 0.30 max	Standard grade. Good strength, ductility, and castability.
HM11XA	Th 1.2; Mn 1.2	For elevated temperatures (up to 800° F).
K1A	Zr 0.7	High damping properties.
FORGINGS AND EXTRUSIONS		
M1A	Mn 1.5	Used where stress relief after welding is not possible and strength requirements not severe.
AZ31B	Al 3.0; Zn 1.0; Mn 0.45	Most common extrusion alloy. Has moderate strength and good formability.
AZ61A	Al 6.5; Zn 1.0; Mn 0.30	Has improved strength over AZ31B, but not as formable.
AZ80A	Al 8.0; Zn 0.5; Mn 0.25	Has improved strength over AZ61A, but less ductility. Can be aged.
ZK21A	Zn 2.3; Zr 0.6	Has good strength and is weldable without need for stress relief. (Available as extrusions only.)
ZK60A	Zn 5.7; Zr 0.55	High strength and toughness. Used mostly in aged condition.
ZK60B	Zn 6.2; Zr 0.55	Higher strength than ZK60A. Extrusions made from pellets rather than billets. (Available as extrusions only.)
EK31XA	Di 3.2; Zr 0.6	For elevated temperatures (up to 500° F). Used in heat treated, quenched, and aged condition. (Available as forgings only.)
HM21A	Th 2.0; Mn 0.5	For elevated temperatures (500-700° F). Used in aged condition. (Available as forgings only.)
HM31A	Th 3.0; Mn 1.5	For elevated temperatures (up to 800° F). (Available as extrusions only.)
A3A	Al 3.0	Low neutron absorptivity. Rapid decay of induced radioactivity.
SHEETS AND PLATES		
AZ31B	Al 3.0; Zn 1.0	Most common sheet alloy. Good formability and weldability.
ZE10A	Zn 1.2; R.E. 0.2	Similar to AZ31B. Does not need stress relief after welding.
HK31A	Th 3.0; Zr 0.7	For elevated temperatures (up to 500° F).
HM21A	Th 2.0; Mn 0.5	For elevated temperatures (500-800° F).
A3A	Al 3.0	Low neutron absorptivity. Rapid decay of induced radioactivity.

COPPER WROUGHT ALLOYS

Alloy and Nominal Composition %[1]	Forms[2]	Machinability[3]	Properties and Applications
COPPERS:			
Electrolytic tough pitch (Cu 99.90 min; O 0.04)	R,D,S,W,T	20	Electrical, thermal conductor. Radiators, wire, flashing.
Deoxidized (Cu 99.90 min; P 0.02)	R,D,S,T	20	Forming, bending good. Plumbing, refrigeration, oil lines.
Oxygen-free copper (Cu 99.92 min)	R,D,S,W,T	20	Deep drawing. Glass-to-metal seals, electronics, bus bars.
BRASSES—Nonleaded:			
Gilding, 95% (Cu 95; Zn 5)	R,W	20	High polish; base for gold plate. Jewelry, emblems, medals.
Commercial bronze, 90% (Cu 90; Zn 10)	R,D,W,T	20	For cold working. Compacts, lipstick cases, screws.
Jewelry bronze, 87.5% (Cu 87.5; Zn 12.5)	R,W	30	Base for gold plate. Zippers, plaques, chains, jewelry.
Red brass, 85% (Cu 85; Zn 15)	R,W,T	30	Resists corrosion. Heat exchangers, trim, conduit, dials.
Low brass, 80% (Cu 80; Zn 20)	R,W	30	For deep drawing. Bellows, musical instruments, dials.
Cartridge brass, 70% (Cu 70; Zn 30)	R,D,W,T	30	Good ductility, strength. Cartridge cases, springs, pins.
Yellow brass (Cu 65; Zn 35)	R,D,W	30	Cold workability and corrosion resistance. Lamps, hinges.
Muntz metal (Cu 60; Zn 40)	R,D,T	40	High strength, low ductility. Condenser plates, forgings.
LEADED BRASSES:			
Leaded coml. bronze (Cu 89; Pb 1.75; Zn 9.25)	R,D,S	80	Screw machine parts, screws, pickling crates, buckles.
Low leaded brass (tubing) (Cu 66; Pb 0.5; Zn 33.5)	T	60	Good machinability, moderate cold workability. J-bends, pipe, fuse parts, pump liners, trap tubes.
Low leaded brass (Cu 65; Pb 0.5; Zn 34.5)	R	60	Hardware (butts, hinges, sink strainers), watch backs.
Medium leaded brass (Cu 65; Pb 1; Zn 34)	R,D,S,W	70	Hardware (butts, gears) clock plates, dials, nuts.
High leaded brass (tubing) (Cu 66; Pb 1.6; Zn 32.4)	T	80	Fabricated by machining, piercing, punching. General purpose screw machine products.
High leaded brass (Cu 65; Pb 2.0; Zn 33.0)	R,D	90	Free machining with good blanking properties. Nameplates, keys, lock parts, gears, clock and watch parts.
Extrahigh leaded brass (Cu 63; Pb 2.5; Zn 34.5)	R	100	For blanking, machining, piercing, stamping; clock plates, nuts, clock and watch backs, clock gears, wheels.
Free-cutting brass (Cu 61.5; Pb 3; Zn 35.5)	R,D,S	100	High speed screw machine parts. Gears, pinions, drilling.
Leaded Muntz metal (Cu 60; Pb 0.6; Zn 39.4)	R	60	Improved machinability. Condenser tube plates.
Free-cutting Muntz metal (Cu 60; Pb 1; Zn 39)	T	70	Improved machinability. Automatic screw machine parts.
Forging brass (Cu 59; Pb 2; Zn 39)	R,D,S	80	Plastic when hot. Forgings, pressings of all kinds.
Architectural bronze (Cu 57; Pb 3; Zn 40)	D,S	90	For forging, free machining. Extrusions, moldings, trim.
TIN & ALUMINUM BRASSES:			
Inhibited admiralty (Cu 71; Zn 28; Sn 1)	R,W,T	30	Strength, ductility, corrosion resistance. Condenser, heat exchanger tubes and plates; auto aerials, marine uses.
Naval brass (Cu 60; Zn 39.25; Sn 0.75)	R,D,S,T	30	Marine uses, condenser plates, shafts, valve stems.
Leaded naval brass (Cu 60; Pb 1.75; Zn 37.5; Sn 0.75)	R,D,S	70	Like free-cutting brass with more corrosion resistance.
Manganese bronze (A) (Cu 58.5; Fe 1.4; Zn 39.0; Sn 1; Mn 0.1)	R,D,S	30	Wear resistance, high strength. Clutch discs, pump rods, valve stems and bodies, coal screens, condenser plates.
Aluminum brass (Cu 76; Zn 22; Al 2)	T	30	Resists impingement. Condenser and heat exchanger tubes.

(Continued on Page S-22)

COPPER WROUGHT ALLOYS (continued)

Alloy and Nominal Composition %[1]	Forms[2]	Machinability[3]	Properties and Applications
PHOSPHOR BRONZES (Tin Bronzes):			
Phosphor bronze, 5% (A) (Cu 95; Sn 5)	R,D,S,W,T	20	High tensile, resists corrosion, season cracking. Bourdon tubing, diaphragms, switch parts, washers, springs.
Phosphor bronze, 8% (C) (Cu 92; Sn 8)	R,D,S,W	20	For more severe conditions than above.
Phosphor bronze, 10% (D) (Cu 90; Sn 10)	R,D,S,W	20	Extra spring qualities, resists fatigue. Expansion plates.
Phosphor bronze, 1.25% (E) (Cu 98.75; Sn 1.25; P trace)	R,W	20	Good hot working properties but requires careful control. Low duty contacts and springs, hose, cold heading stock.
Free-cutting Phosphor Bronze (Cu 88; Pb 4; Zn 4; Sn 4)	R,D,S	80	Good cold workability, improved machinability. Bearings, bushings, gears, pinions, shafts, thrust washers, valve parts.
CUPRO-NICKEL AND NICKEL SILVERS:			
Cupro-nickel, 30% (Cu 70; Ni 30)	R,D,T	20	Strength, ductility, corrosion resistance. Condensers, meters, plates, heat exchanger tubing, salt water tubing.
Cupro-nickel, 10% (Cu 88.7; Fe 1.3; Ni 10)	R,T	20	Resists salt water. Condenser tubing and plates, pipe.
Nickel silver, 65-18 (Cu 65; Zn 17; Ni 18)	R,D,W	20	Deep drawing, resists tarnish. Zippers, flatware.
Nickel silver, 55-18 (Cu 55; Zn 27; Ni 18)	R,D,W	30	Spring stock, resists fatigue. Springs, diaphragms.
Nickel silver, 65-15 (Cu 65; Zn 20; Ni 15)	R	20	Resists tarnish; hollow ware, nameplates, camera parts.
Nickel silver, 65-12 (Cu 65; Zn 23; Ni 12)	R,D,W	20	Deep drawing. Hollow ware, slide fasteners, trim.
Nickel silver, 65-10 (Cu 65; Zn 25; Ni 10)	R,D,W	20	Similar to above. Screws, flatware, platers' bars.
SILICON BRONZES (Copper-Silicon Alloys):			
High-silicon bronze A (Cu 94.8 min; Si 3)	R,D,S,W,T	30	Corrosion resistance of copper; physicals of mild steel. Hydraulic lines, tanks, bolts, screws, pole line hardware.
Low-silicon bronze B (Cu 96.0 min; Si 1.5)	R,D,S,W,T	30	Cold headed bolts, nuts, screws; clamps, cotter pins.

1. Only major elements listed.
2. Abbreviations: R—Rolled flat products.
   D—Rod and drawn flat products. T—Tubing.
   S—Shapes. W—Wire (except flat).
3. Basis: Free-cutting brass=100.

COPPER ALLOYS

Wrought alloys not listed in the Copper & Brass Research Association's Manual of Standard Alloys

Name and Producer	Nominal Composition %	Forms and Applications
Boron Deoxidized Copper, 117 American Brass Co.	Cu 99.98; B 0.02	Strip, wire, rods, bars—High conductivity deoxidized copper for electrical apparatus.
High-Thermo (Mod. Electrolytic Tough Pitch) Phelps Dodge Copper Products Corp.	Cu 99.90 (plus small quantity of an element added to increase resistance to annealing)	Wire, bars, commutator section stock—High conductivity electrical uses, as in transmission lines, bus bars, commutator segments, where greater retention of high tensile is desired at temperatures that normally soften electrolytic copper.
Amzirc, 992 (Zirconium Copper) Bridgeport Brass Co.	Cu 99.88; Zr 0.12	Rods—Soldering iron tips, resistance welding wheels and electrodes, miscellaneous current carrying parts, high temperature uses.
Sulfur Copper, 120 Bridgeport Brass Co.	Cu 99.7; S 0.3	Rods—Electrical parts, welding torch tips, soldering iron tips.
Phosphorized Arsenical Copper, 108 American Brass Co.	Cu 99.68; P 0.02; As 0.30	Tubes—Condenser and heat exchanger tubes.
Tellurium Copper, 112 Bridgeport Brass Co.	Cu 99.5; Te 0.5	Rods—Free machining copper. Electrical connectors.
Tellurium Copper Chase Brass & Copper Co.	Cu 99.50; Te 0.50; P 0.007	Rods—Screw machine and other parts requiring high conductivity.
Tellurium Copper, 033 Scovill Mfg. Co.	Cu 99.50; Te 0.50	Rods—Screw machine products.
Tellurium Copper, 799 Mueller Brass Co.	Cu 99.50; Te 0.50	Rods, bars, die-pressed forgings—Gas cutting torch and welding tips, screw machine parts.
Revere Free Cutting Copper (Tellurium Bearing Copper) Revere Copper & Brass Inc.	Cu 99.50; Te 0.50; P 0.007 max	Rods, extruded shapes, forgings—Electrical parts, welding tips.
Tellurium Copper, 127 American Brass Co.	Cu 99.49; Te 0.50; P 0.01	Rods, bars, die-pressed forgings—Gas cutting torch and welding tips. High conductivity screw machine products.
Chromium Copper, 999 American Brass Co.	Cu 99.05; Si 0.10; Cr 0.85	Sheets, strip, plates, wire, rods, bars—Switches, circuit breakers, contact points on resistance welding electrodes, grid supports, vacuum tubes.
Chromium Copper, 902 Mueller Brass Co.	Cu 99.05; Si 0.10; Cr 0.85	Sheets, strip, plates, wire, rods, bars—Switches, circuit breakers, contact points on resistance welding electrodes, grid supports, vacuum tubes.
Ampcoloy, 97 (Chromium Copper) Ampco Metal Inc.	Cu 99.00; Cr 1.00	Rods, bars, shapes, forgings, plates, castings—Spotwelding tips, seamwelder rolls, flashwelding dies, electrical contacts, Properzi wheels, commutator segments, rotor bars, plating rolls.
Hitenso, 961 (Cadmium Copper) American Brass Co.	Cu 99.00; Cd 1.00	Sheets, strip, plates, wire, rods, bars—Electrical conductors, electrodes for resistance welding.
Leaded Copper, 126 American Brass Co.	Cu 99.00; Pb 1.00	Rods and bars—High conductivity screw machine products.
Phosnic Bronze (Nickel-Phosphorus Bronze) Chase Brass & Copper Co.	Cu 98.65; Ni 1.10; P 0.25	Rods—Rivets, screws, springs, electrical parts.
Hitenso, 965 (Cadmium Bronze) American Brass Co.	Cu 98.60; Sn 0.60; Cd 0.80	Sheets, strip, plates, wire, rods, bars—Wire and cable for electrical conductors.
Telnic Bronze (Nickel-Phosphorus Bronze) Chase Brass & Copper Co.	Cu 98.15; Ni 1.10; Te 0.50; P 0.25	Rods—Forgings and screw machine parts requiring high strength, good conductivity.
Leaded Nickel Copper, 831 American Brass Co.	Cu 97.80; Pb 1.00; Ni 1.00; P 0.20	Rods—Electrical equipment, high conductivity screw machine products.
Nironze, 635 Bridgeport Brass Co.	Cu 97.5; Ni 1.9; Si 0.6	Rods—Pole line hardware, switch gear, cold formed nuts, bolts.
Cunisil, 837 American Brass Co.	Cu 97.50; Ni 1.90; Si 0.60	Rods—Electrical equipment.
Olympic-Type B Chase Brass & Copper Co.	Cu 97.50; Si 1.50; Zn 1.00	Wire, rods—Bolts and nuts.
Silnic Bronze Chase Brass & Copper Co.	Cu 97.5; Ni 1.90; Si 0.60	Wire, rods, bars—Bolts and nuts, pole line hardware, valve stems, electrical contacts, shafts.
Olympic-Type A Chase Brass & Copper Co.	Cu 96.00; Si 3.00; Zn 1.00	Sheets, strip—Bearing plates, evaporators, certain marine hardware, special tanks.
Everdur, 1012 (Leaded Silicon Bronze) American Brass Co.	Cu 95.60; Pb 0.40; Si 3.00; Mn 1.00	Rods—Screw machine products.

Name and Producer	Nominal Composition %	Forms and Applications
Calsun Bronze, 951 American Brass Co.	Cu 95.50; Sn 2.00; Al 2.50	Wire, rods, bars—Wire and cable for electrical conductors.
Aluminum Bronze, 5% Revere Copper & Brass Inc.	Cu 95.00; Al 5.00	Tubes—Condenser tubes.
Ambraloy, 901 (Aluminum Bronze, 5%) American Brass Co.	Cu 95.00; Al 5.00	Tubes, rods, bars, sheets, strip, plates, wire—Condenser and heat exchanger tubes, foreign coinage, architectural decoration to imitate gold.
Ambronze, 474 American Brass Co.	Cu 94.97; Zn 4.00; Sn 1.00; P 0.03	Sheets, strip, plates, wire—Electrical switch parts and springs.
Leaded Phosphor Bronze, (B)-379 American Brass Co.	Cu 93.90; Sn 5.00; Pb 1.00; P 0.10	Strip, wire, rods, bars, tubes—Screw machine products.
Brazing Bronze, 222 Olin Mathieson Chemical Corp.	Cu 93.00; Zn 4.70; Fe 2.30	Sheets, strip—Retains fine grain size up to about 1600-1700° F. Used for furnace brazing, electrical applications such as circuit breaker arms, terminals.
Ambronze, 404 American Brass Co.	Cu 92.00; Zn 7.00; Sn 1.00	Strip, rods, bars—Spring and contact applications in electrical equipment and hardware.
Tin Brass, 2% Scovill Mfg. Co.	Cu 92.00; Sn 2.00; Zn 6.00	Electrical and radio springs and contacts.
Trembronze (Tin Brass) Miller Co.	Cu 92.00; Sn 2.00; Zn 6.00	Strip—General spring and contact applications in electrical and hardware fields.
NEB-Bronze, 2% New England Brass Co.	Cu 92.00; Sn 2.00; Zn 6.00	Strip—Springs, switch parts for electrical and hardware fields.
Ambraloy, 928 (Aluminum Bronze, 8%) American Brass Co.	Cu 92.00; Al 8.00	Sheets, strip, plates, wire, rods, bars—Valve stems, coins, medallions, plaques.
Panda QT Bronze Plume & Atwood Mfg. Co.	Cu 91.50; Sn 2.25; Zn 6.25	Strip—Spring and contact applications. Used where the extreme fatigue life of the higher tin bronzes is not required.
Aluminum Bronze, 7% Revere Copper & Brass Inc.	Cu 91.00; Al 7.00; Fe 2.00	Sheets, plates—Tanks, process equipment.
Aluminum Silicon Bronze Revere Copper & Brass Inc.	Cu 91.00; Al 7.00; Si 2.00	Rods, forgings—Bolts, nuts, gears, pinions, valve bushings, bodies and stems.
Silicon Aluminum Bronze Chase Brass & Copper Co.	Cu 91.00; Si 1.75; Al 7.25	Rods—Valve stems, fasteners.
Aluminum Silicon Bronze, 802 Mueller Brass Co.	Cu 91.00; Al 7.00; Si 2.00	Rods, die-pressed forgings—Screw machine parts, pole line hardware, valve stems, aircraft parts.
Duronze, 707 (Aluminum Silicon Bronze) Bridgeport Brass Co.	Cu 91.00; Al 7.00; Si 2.00	Rods, bars—Valve stems and parts, wire cable connector parts, bolts and nuts, hot forged parts, marine hardware, gears, pinions. Good corrosion resistance.
Everdur, 1014 (Aluminum Silicon Bronze) American Brass Co.	Cu 90.75; Al 7.25; Si 2.00	Rods—Screw machine parts, die pressed forgings.
Ampco Grade 8 (Aluminum Bronze D) Ampco Metal Inc.	Cu 90.75; Al 6.50; Fe 2.25; Sn 0.25	Sheets, plates, extruded rods, tubes, pipe, shapes—Mechanical and processing fabrications, conveyors, liners, heads, slides, gibs, and wear strips.
High Strength Commercial Bronze, 286 American Brass Co.	Cu 90.25; Zn 6.90; Pb 1.75; P 0.10; Ni 1.00	Rods, bars, tubes—Pole line hardware and other parts subject to outdoor exposure.
Nickel Leaded Commercial Bronze Chase Brass & Copper Co.	Cu 90.25; Zn 6.90; Ni 1.00; P 0.10; Pb 1.75	Rods—Machined nuts, screw machine parts.
Tin Brass, 1% Scovill Mfg. Co.	Cu 90.00; Sn 1.00; Zn 9.00	Strip—Special springs, contacts, jewelry, sockets.
Tin Brass, 0.5% Scovill Mfg. Co.	Cu 90.00; Sn 0.50; Zn 9.50	Strip—Jewelry, bearings, sockets, clips, weather strip.
Lubaloy, X80 (Tin Brass) Olin Mathieson Chemical Corp.	Cu 90.00; Zn 8.25; Sn 1.75	Sheets, strip—Radio tube socket contacts, fuse clips, contact springs, lock washers, solderless connectors, jewelry, coins, electric fan blades, medallions.
Lubaloy, 84 (Tin Brass) Olin Mathieson Chemical Corp.	Cu 90.00; Zn 9.50; Sn 0.50	Sheets, strip—Bearing alloy for bushings, bearings, clutch plates, thrust washers, jewelry, bezels, weather strip.
NEB-Bronze, 1% New England Brass Co.	Cu 90.00; Sn 1.00; Zn 9.00	Strip—Springs, switch parts for electrical and hardware field.
Free-Cutting Commercial Bronze, 96 Titan Metal Mfg. Co.	Cu 90.00; Pb 2.00; Ni 1.00; P 0.10; Zn 6.90	Rods—Screw machine parts where resistance to dezincification is an important consideration.
Scovill, 215 Scovill Mfg. Co.	Cu 90.00; Pb 2.00; Zn 8.00	Rods—High conductivity bronze.
Leaded Bearing Bronze, 116 Olin Mathieson Chemical Corp.	Cu 89.25; Zn 2.75; Sn 4.00; Pb 4.00	Sheets, strip—Bearings and bushings in automobiles, aircraft.
Avialite, 915 American Brass Co.	Cu 89.25; Sn 0.40; Al 9.25; Ni 0.50; Fe 0.60	Rods, bars, die-pressed forgings—Pickling crates. Used where strength and resistance to corrosion at high temperatures are required as in parts for internal combustion engines.
Contact Bronze, 92 (Tin Brass) Bridgeport Brass Co.	Cu 89.00; Sn 1.80; Zn 8.20	Strip—Electrical and radio spring applications.
Ambronze, 420 American Brass Co.	Cu 88.00; Zn 11.00; Sn 1.00	Strip, wire, tubes—Spring and switch parts for electrical apparatus and hardware.
Ni-Vee Bronze Seymour Mfg. Co.	Cu 88.00; Ni 5.00; Sn 5.00; Zn 2.00	Strip, rods—Valve stem fasteners, hardware. Heat treatable alloy.
Superloy (Tin Brass) Phelps Dodge Copper Products Corp.	Cu 88.00; Sn 2.00; Zn 10.00	Tubes—Condensers and heat exchangers.
Ambronze, 421 (Tin Brass) American Brass Co.	Cu 88.00; Sn 2.00; Zn 10.00	Tubes—Condensers and heat exchangers.
Brmco Bronze Bridgeport Rolling Mills Co.	Cu 88.00; Sn 2.00; Zn 10.00	Strip—Cold workable alloy, characterized by its toughness, ductility, spring quality, high tensile strength, and high electrical conductivity. Used in hardware and electrical fields.
Ambronze, 422 American Brass Co.	Cu 87.00; Sn 2.00; Zn 11.00	Strip, wire, rods, bars—Spring and switch parts for electrical apparatus and hardware.
Spring Bronze Scovill Mfg. Co.	Cu 87.00; Sn 2.00; Zn 11.00	Strip, tubes—Springs, condenser tubes.
Ampco Grade 15 (Aluminum Bronze) Ampco Metal Inc.	Cu 87.00; Al 9.50; Fe 3.20	Extruded solid and hollow rounds, shapes—Gears, small worm wheels, bushings, valve seats, guides.
Aluminum Bronze Olin Mathieson Chemical Corp.	Cu 87.00; Zn 7.00; Al 4.00; Fe 2.00	Sheets, strip—Bearings, bushings, thrust washers.
Brmcolloy, 300 Bridgeport Rolling Mills Co.	Cu 86.00; Sn 2.00; Zn 12.00	Strip—High fatigue resistance for electrical contacts, springs, relay parts.
Brmcolloy, 200 Bridgeport Rolling Mills Co.	Cu 86.00; Sn 1.00; Zn 13.00	Strip—Sash chain, electrical contacts, switch parts and fuse clips.
Brmcolloy, 100 Bridgeport Rolling Mills Co.	Cu 86.00; Sn 0.50; Zn 13.50	Strip—Jewelry chain, switch and relay components.

(Continued on Page S-24)

COPPER ALLOYS (continued)

Name and Producer	Nominal Composition %	Forms and Applications
Ampco Grade 18 (Aluminum Bronze) Ampco Metal Inc.	Cu 85.50; Al 10.50; Fe 3.50	Extruded solid and hollow rounds, shapes—Bushings, bearings, worms and worm wheels, valve seats and guides, hydraulic valve parts, plungers, pump rods, guide-pin bushings, gibs, slides.
Manganese Red Brass, 507 American Brass Co.	Cu 85.00; Zn 14.00; Mn 1.00	Sheets, strip—Resistance spotwelding and seamwelding.
Hardware Bronze, 267 American Brass Co.	Cu 85.00; Zn 13.25; Pb 1.75	Rods, bars—Hardware, screw machine products.
Glo-Ray New England Brass Co.	Cu 85.00; Sn 0.50; Zn 14.50	Strip—Jewelry and allied fields. Used where color and strength are factors.
Silicon Red Brass, 1027 American Brass Co.	Cu 82.00; Zn 17.00; Si 1.00	Sheets, strip, plates, wire—Electrical resistance welding.
Ambraloy, 917 American Brass Co.	Cu 82.00; Al 9.50; Mn 1.00; Ni 5.00; Fe 2.50	Plates, rods, bars, die-pressed forgings—Tube sheets for heat exchangers.
Manganese Red Brass Bridgeport Brass Co.	Cu 81.00; Mn 1.25; Zn 17.75	Strip—Spotwelding and seamwelding.
High-Silicon Brass Titan Metal Mfg. Co.	Cu 81.00; Si 4.00; Zn 15.00	Rods, diecastings, forgings—Valve parts, pole line hardware.
Silicon Brass, 284 Bridgeport Brass Co.	Cu 81.00; Si 4.25; Zn 14.75	Rods—Valve stems.
Silicon Brass Revere Copper & Brass Inc.	Cu 81.00; Si 4.00; Zn 15.00	Rods—Valve parts.
Ampcoloy, 45 (Nickel Aluminum Bronze) Ampco Metal Inc.	Cu 81.00; Al 10.20; Fe 2.70; Ni 5.00; Mn 1.00	Rods, bars, shapes, hollow bars, forgings, castings—Valve guides, gears, shafting, propellers, bushings, tube sheets.
Manganese Cartridge Brass Bridgeport Brass Co.	Cu 70.00; Mn 1.25; Zn 28.75	Strip—Fabricates as well as 70-30 brass. Good for spotwelding and seamwelding.
Manganese Brass, 510 American Brass Co.	Cu 70.00; Zn 29.00; Mn 1.00	Sheets, strip—Resistance spotwelding and seamwelding.
Manganese Brass Revere Copper & Brass Inc.	Cu 70.00; Mn 1.25; Zn 28.75	Strip—Used for parts requiring spotwelding and seamwelding.
Manganese Brass, 277 Olin Mathieson Chemical Corp.	Cu 70.00; Zn 28.90; Mn 1.10	Sheets, strip—Same physical characteristics as cartridge brass except for lower electrical conductivity, permitting easier spotwelding and seamwelding.
Manganese Bronze, 112 (Grade B) Titan Metal Mfg. Co.	Cu 64.00; Mn 4.00; Al 3.00; Fe 3.00; Zn 26.00	Rods, forgings—High strength, toughness, and hardness. Used for work gears, valve parts.
Leaded Flanging Brass Chase Brass & Copper Co.	Cu 62.5; Pb 2.0; Zn 35.5	Sheets, strip—Screw machine products involving secondary operations such as flanging, knurling, roll threading, spinning, and staking.
Nitany, 31 (Leaded Brass) Titan Metal Mfg. Co.	Cu 62.00; Pb 1.70; Si 36.30	Rods—For difficult thread rolling operations and other screw machine products requiring operations such as staking, turning, and flanging.
Thread Rolling-Free Cutting Brass, 212 Mueller Brass Co.	Cu 61.00; Pb 1.75; Zn 37.25	Rods—Screw machine products.
Nonleaded Bearing Alloy, 601 Mueller Brass Co.	Cu 61.00; Mn 2.50; Si 1.00; Zn 35.50	Rods—Screw machine products.
Medium-Leaded Bearing Alloy, 602	Cu 61.00; Mn 2.50; Si 1.00; Pb 1.00; Zn 34.50	Rods—Screw machine products, shaft bushings.
High-Leaded Bearing Alloy, 604 Mueller Brass Co.	Cu 61.00; Mn 2.50; Si 1.00; Pb 2.50; Zn 33.00	Rods—Screw machine products.
Low-Leaded Bearing Alloy, 605 Mueller Brass Co.	Cu 61.00; Mn 2.50; Si 1.00; Pb 0.50; Zn 35.00	Rods—Screw machine products, hydraulic pump connecting rod retainers.
Medium-Leaded Forgeable Bearing Alloy, 603 Mueller Brass Co.	Cu 60.00; Mn 2.50; Si 1.00; Pb 1.00; Zn 35.50	Forgings—Hydraulic transmission gears, hydraulic pump cylinder barrels.
Free-Cutting Manganese Bronze (A) Leaded Titan Metal Mfg. Co.	Cu 59.00; Pb 0.70; Sn 0.90 Fe 0.90; Mn 0.20; Zn 38.30	Rods, forgings—Valve parts, marine hardware.
Free-Cutting Manganese Bronze (A) Leaded, 241A Mueller Brass Co.	Cu 59.00; Pb 0.70; Sn 0.90 Fe 0.90; Mn 0.20; Zn 38.30	Rods, forgings—Screw machine products, valve parts, aircraft parts.
Forgeable Bearing Alloy, 600 Mueller Brass Co.	Cu 58.00; Mn 2.50; Si 0.75; Al 1.50; Zn 37.25	Forgings, rods—Screw machine products, chain saw clutch bearings, squirrel cage feed fingers, hydraulic pump driving cams, lead screw nuts.
Nickel Silver, 12%-743 American Brass Co.	Cu 56.50; Zn 31.25; Ni 12.00; Mn 0.25	Strip—Springs and instrument parts.
Tinicosil, 54 (Extruded Leaded Nickel Silver) Titan Metal Mfg. Co.	Cu 47.00; Ni 10.00; Pb 2.25; Mn 2.00; Zn 38.75	Round and hexagon rods—Screw machine products, instrument parts, fishing tackle, valve and plumbing parts.
Tinicosil, 53 (Extruded Nickel Silver) Titan Metal Mfg. Co.	Cu 46.00; Ni 10.00; Zn 44.00	Forgings—Plumbing, valves, instrument parts.
Leaded Nickel Silver, 10%-825 American Brass Co.	Cu 45.00; Zn 42.00; Ni 10.00; Pb 1.00; Mn 2.00	Rods, bars, extruded shapes, forgings—Screw machine products, instrument parts, ornamental architectural shapes.

COPPER CASTING ALLOYS

Alloy and Nominal Composition %	Machinability*	Properties and Applications
ASTM specification B143-52		
1A—Tin bronze (Cu 88; Sn 10; Zn 2)	50	Bearings and bushings, fasteners, valve bodies for temperatures to 550° F, steam pressure castings, oil pumps, carburetors, gears.
1B—Tin bronze (Cu 88; Sn 8; Zn 4)	50	
2A—Leaded tin bronze (Cu 88; Sn 6; Pb 1.50; Zn 4.5)	60	
2B—Leaded tin bronze (Cu 87; Sn 8; Pb 1; Zn 4)	60	
ASTM specification B144-52		
3A—High-leaded, tin bronze (Cu 80; Sn 10; Pb 10; Ni 0.75 max)	80	Bearing bronzes. Acid resisting. Those with highest copper content for heaviest loads. Bearings, shoes, wedges, bushings and uses where an antifriction, soft material is needed.
3B—High-leaded, tin bronze (Cu 83; Sn 7; Pb 7; Zn 3; Ni 0.50 max)	70	
3C—High-leaded, tin bronze (Cu 85; Sn 5; Pb 9; Zn 1; Ni 0.50 max)	70	
3D—High-leaded, tin bronze (Cu 78; Sn 7; Pb 15; Ni 0.75 max)	80	
3E—High-leaded, tin bronze (Cu 70; Sn 5; Pb 25; Ni 0.75 max)	90	
ASTM specification B145-52		
4A—Leaded red brass (Cu 85; Sn 5; Pb 5; Zn 5)	90	General purpose, moderate strength castings. Superior machinability. Plumbing goods, pumps, hardware, ornamental objects, low pressure valves. Air, gas, oil, and water fittings.
4B—Leaded red brass (Cu 83; Sn 4; Pb 6; Zn 7)	90	
5A—Leaded semired brass (Cu 81; Sn 3; Pb 7; Zn 9)	90	
5B—Leaded semired brass (Cu 76; Sn 3; Pb 6; Zn 15)	90	
ASTM specification B146-52		
6A—Leaded yellow brass (Cu 72; Sn 1; Pb 3; Zn 24)	80	Same type uses as red brasses. More difficult to cast, but sometimes preferred for color. Ferrules, andirons, furniture hardware, ship trimming.
6B—Leaded yellow brass (Cu 67; Sn 1; Pb 3; Zn 29)	80	
6C—Leaded yellow brass (Cu 61; Sn 1; Pb 1; Zn 36.35; Al 0.15)	..	

Alloy and Nominal Composition %	Machinability*	Properties and Applications
ASTM specification B147-52		
7A—Leaded, high strength, yellow brass (Cu 61; Sn 0.75; Pb 0.75; Zn 35.5; Fe 1; Al 0.75; Mn 0.25)	60	Used where strength and toughness are required. Heavy duty valve stems, gears, cams, bearings, hydraulic cylinder parts, marine fittings, lever arms, pump bodies, gas engine bases, brackets, screwdown nuts, hydraulic cylinder parts.
8A—High strength yellow brass (Cu 58; Zn 39.25; Fe 1.25; Al 1.25; Mn 0.25)	30	
8B—High strength manganese bronze (Varies to meet requirements)	30	
8C—High strength manganese bronze (Varies to meet requirements)	20	
ASTM specification B148-52		
9A—Aluminum bronze (Cu 88; Fe 3; Al 9)	20	Strong, corrosion resistant alloys. Good high heat strength; 9B, C, and D are heat treatable. Gears, bushings, bearings, propellers, pickling baskets, valve seats, marine equipment, worms, heavy duty feed nuts.
9B—Aluminum bronze (Cu 89; Fe 1; Al 10)	35	
9C—Aluminum bronze (Cu 85; Fe 4; Al 11)	20	
9D—Aluminum bronze (Cu 81; Fe 4; Ni 4; Al 11)	20	
ASTM specification B149-52		
10A—Leaded nickel brass (Cu 57; Sn 2; Pb 9; Zn 20; Ni 12)	70	Sometimes called nickel silvers. Corrosion resistant hardware, plumbing fixtures, ornamental castings, dairy and soda fountain equipment, musical instruments, boat and railroad car fittings, trim.
11A—Leaded nickel bronze (Cu 64; Sn 4; Pb 4; Zn 8; Ni 20)	..	
11B—Leaded nickel bronze (Cu 66.5; Sn 5; Pb 1.5; Zn 2; Ni 25)	..	
ASTM specification B198-58		
12A—Silicon bronze (Sn 1 max; Pb 0.5 max; Zn 4 max; Fe 2.5 max; Mn 1.5 max; Al 1.5 max; Si 1-5; Cu rem)	..	Valve parts for corrosive conditions; good corrosion resistance in absence of oxygen. Naval parts, chemical parts, brackets, pole line hardware.
13A—Silicon brass (Pb 1 max; Zn 12-16; Si 2.5-4; Cu rem)	..	
13B—Silicon brass (Pb 0.5 max; Zn 12-16; Si 3-5; Cu rem)	..	
No ASTM specification		
Silicon-aluminum bronze (Cu 91; Al 7; Si 2)	50	Corrosion resistant. Higher strength than silicon brasses. Valves, radar parts, pressure castings. Heat treatable. Welding tips, nonsparking tools.
Silicon-aluminum bronze (Cu 90; Al 7; Si 3)	50	
Beryllium bronze (Cu 96.5; Ni 1.1; Be 2.2-2.8)	20-40	

*Basis: Free cutting brass=100.

ALUMINUM WROUGHT ALLOYS

Aluminum Assn. Designation	Chemical Composition % max or range, Al remainder	Commercial Forms	Properties and Applications
EC	Al 99.45 min	S,W,B,E,T	Electric conductors.
1060*	Si 0.25; Fe 0.35; Cu 0.05; Mn 0.03; Mg 0.03; Zn 0.05; Ti 0.03; Al 99.60 min; others 0.03 each	S,T	Chemical equipment and railroad tank cars.
1100*	Si & Fe 1.0; Cu 0.20; Mn 0.05; Zn 0.10; Al 99.00 min	S,W,B,E,T,F	Sheet metalwork, spun hollow ware, and decorative parts. Good formability. Impact extrusions.**
1130	Si & Fe 0.7; Cu 0.20; Al 99.30 min	S	Used primarily for reflector sheet in lighting fixtures.
1145	Si & Fe 0.55; Cu 0.05; Mn 0.05; Al 99.45 min; others 0.03 each	Foil	Used in making foil.
2011	Si 0.40; Fe 0.7; Cu 5.0-6.0; Zn 0.30; Pb 0.20-0.6; Bi 0.20-0.6	W,B	Screw machine products.
2014*	Si 0.50-1.2; Fe 1.0; Cu 3.9-5.0; Mn 0.40-1.2; Mg 0.20-0.8; Cr 0.10; Zn 0.25; Ti 0.15	S,W,B,E,T,F	Heavy duty structures, aircraft, and truck frames. High strength with good machinability.
Alclad 2014	(same as above)	S	Corrosion resistance is better than 2014.
2017	Si 0.8; Fe 1.0; Cu 3.5-4.5; Mn 0.40-1.0; Mg 0.20-0.8; Cr 0.10; Zn 0.25	W,B	Screw machine products. Higher strength than 2011.
2018	Si 0.9; Fe 1.0; Cu 3.5-4.5; Mn 0.20; Mg 0.45-0.9; Cr 0.10; Ni 1.7-2.3; Zn 0.25	F	Aircraft engine cylinder heads and pistons. High strength with good machinability.
2024	Si 0.50; Fe 0.50; Cu 3.8-4.9; Mn 0.30-0.9; Mg 1.2-1.8; Cr 0.10; Zn 0.25	S,W,B,E,T	Aircraft structures, truck wheels, screw machine products. High strength and hardness.
Alclad 2024	(same as above)	S	Same as 2024 with greater corrosion resistance.
2025	Si 0.50-1.2; Fe 1.0; Cu 3.9-5.0; Mn 0.40-1.2; Mg 0.05; Cr 0.10; Zn 0.25; Ti 0.15	F	Propeller blades and other high strength forgings.
2117	Si 0.8; Fe 1.0; Cu 2.2-3.0; Mn 0.20; Mg 0.20-0.50; Cr 0.10; Zn 0.25	W	Cold heading wire and rivets.
2218	Si 0.9; Fe 1.0; Cu 3.5-4.5; Mn 0.20; Mg 1.2-1.8; Cr 0.10; Ni 1.7-2.3; Zn 0.25	F	Aircraft engine cylinder heads and pistons, jet engine impellers and compressor rings.
3003*	Si 0.6; Fe 0.7; Cu 0.20; Mn 1.0-1.5; Zn 0.10	S,W,B,E,T,F	Cooking utensils, pressure vessels, tanks, piping, architectural uses, builders' hardware, foil.
Alclad 3003	(same as above)	S,T	Tea kettles, chemical equipment, heat exchange tubes, pressure vessels, storage tanks, flashing.
3004*	Si 0.30; Fe 0.7; Cu 0.25; Mn 1.0-1.5; Mg 0.8-1.3; Zn 0.25	S	Special sheet metalwork, shoe eyelets, pressure vessels, storage tanks.
Alclad 3004	(same as above)	S	Industrial building sheets and flashing.
4032	Si 11.0-13.5; Fe 1.0; Cu 0.50-1.3; Mg 0.8-1.3; Cr 0.10; Ni 0.50-1.3; Zn 0.25	F	Pistons, forging stock.
4043*	Si 4.5-6.0; Fe 0.8; Cu 0.30; Mn 0.05; Mg 0.05; Zn 0.10; Ti 0.20	W	Intermediate strength welding wire. Cladding on brazing sheets.
5005	Si 0.40; Fe 0.7; Cu 0.20; Mn 0.20; Mg 0.50-1.1; Cr 0.10; Zn 0.25	S	Refrigerator uses, architectural and auto trim.
5050*	Si 0.40; Fe 0.7; Cu 0.20; Mn 0.10; Mg 1.0-1.8; Cr 0.10; Zn 0.25	S,W,B,T	Decorative refrigerator parts, builders' hardware, coiled tubes; architectural and auto trim.
Alclad 5050	(same as above)	S	Better corrosion resistance than 5050.
5052*	Si & Fe 0.45; Cu 0.10; Mn 0.10; Mg 2.2-2.8; Cr 0.15-0.35; Zn 0.10	S,W,B,T	Sheet metalwork; appliances; bus, truck, and marine uses. Workability and weldability good.
5056*	Si 0.30; Fe 0.40; Cu 0.10; Mn 0.05-0.20; Mg 4.5-5.6; Cr 0.05-0.20; Zn 0.10	W	High strength aluminum wire, rivets, staple wire, zippers.
Alclad 5056	(same as above)	W	Insect screen cloth.
5083	Si 0.40; Fe 0.40; Cu 0.10; Mn 0.30-1.0; Mg 4.0-4.9; Cr 0.05-0.25; Zn 0.25; Ti 0.15	S,W,B,E	High strength welded structures, tanks, marine uses.
5086	Si 0.40; Fe 0.50; Cu 0.10; Mn 0.20-0.7; Mg 3.5-4.5; Cr 0.05-0.25; Zn 0.25	S,W,B,E	Structural alloy with good weldability. Trailer tanks, unfired pressure vessels, towers, elevator cars and truck frames, marine applications.
5154*	Si & Fe 0.45; Cu 0.10; Mn 0.10; Mg 3.1-3.9; Cr 0.15-0.35; Zn 0.20; Ti 0.20	S,W,B,E,T	Pressure vessels, marine uses. High strength welding wire.
5254*	Si & Fe 0.45; Cu 0.05; Mn 0.01; Mg 3.1-3.9; Cr 0.15-0.35; Zn 0.20; Ti 0.05	S,W,B,T	High purity version of 5154. Special uses in the chemical industry.
5356*	Si & Fe 0.50; Cu 0.10; Mn 0.05-0.20; Mg 4.5-5.5; Cr 0.05-0.20; Zn 0.10; Ti 0.06-0.20	W	Welding wire.
5357	Si 0.12; Fe 0.17; Cu 0.07; Mn 0.15-0.45; Mg 0.8-1.2	S	Refrigerator parts, builders' hardware.

(Continued on Page S-26)

ALUMINUM WROUGHT ALLOYS (continued)

Aluminum Assn. Designation	Chemical Composition % max or range. Al remainder	Commercial Forms	Properties and Applications
5454	Si & Fe 0.40; Cu 0.10; Mn 0.50-1.0; Mg 2.4-3.0; Cr 0.05-0.20; Zn 0.25; Ti 0.20	S,B,E,T	Strong welded structures which operate at slightly elevated temperatures. Tanks, tubes, pipes.
5456	Si & Fe 0.40; Cu 0.10; Mn 0.50-1.0; Mg 4.7-5.5; Cr 0.05-0.20; Zn 0.25; Ti 0.20	S,W,B,E	Uses same as 5083. Available as welding filler wire.
5457	Si 0.08; Fe 0.10; Cu 0.20; Mn 0.15-0.45; Mg 0.8-1.2; others 0.03 each, total 0.10	S	Used for trim on autos. Takes a bright anodized finish.
5652*	Si & Fe 0.40; Cu 0.04; Mn 0.01; Mg 2.2-2.8; Cr 0.15-0.35; Zn 0.10	S,W,B,T	High purity version of 5052. Special uses in chemical field; tanks for hydrogen peroxide.
6011	Si 0.6-1.2; Fe 1.0; Cu 0.40-0.9; Mn 0.8; Mg 0.6-1.2; Cr 0.30; Ni 0.20; Zn 1.5; Ti 0.20	S	Roll formed products such as lamp bases. Venetian blind stock.
6053	Si 45-65% of Mg; Fe 0.35; Cu 0.10; Mg 1.1-1.4; Cr 0.15-0.35; Zn 0.10	W	Rivet wire and rivets.
6061	Si 0.40-0.8; Fe 0.7; Cu 0.15-0.40; Mn 0.15; Mg 0.8-1.2; Cr 0.15-0.35; Zn 0.25; Ti 0.15	S,W,B,E,T,F	Heavy duty structures where corrosion resistance is needed. Bridge railings, marine uses, furniture.
Alclad 6061	(same as above)	S	Better corrosion resistance and appearance.
6062	Si 0.40-0.8; Fe 0.7; Cu 0.15-0.40; Mn 0.15; Mg 0.8-1.2; Cr 0.04-0.14; Zn 0.25; Ti 0.15	E,T	Alternate for 6061; preferred for extrusions and tubes.
6063	Si 0.20-0.6; Fe 0.35; Cu 0.10; Mn 0.10; Mg 0.45-0.9; Cr 0.10; Zn 0.10; Ti 0.10	E,T	Pipe, railings, builders' hardware, windows, architectural uses, truck and trailer flooring.
6066	Si 0.9-1.8; Fe 0.50; Cu 0.7-1.2; Mn 0.6-1.1; Mg 0.8-1.4; Cr 0.40; Zn 0.25; Ti 0.20	W,B,E,T,F	Trailer and aircraft structures. Strength and corrosion resistance between 6061 and 2024.
6101*	Si 0.30-0.7; Fe 0.50; Cu 0.10; Mn 0.03; Mg 0.35-0.8; Cr 0.03; Zn 0.10; B 0.06; others 0.03 each, total 0.10	W,B,E,T	High strength electric conductor.
6151	Si 0.6-1.2; Fe 1.0; Cu 0.35; Mn 0.20; Mg 0.45-0.8; Cr 0.15-0.35; Zn 0.25; Ti 0.15	F	Intricate forgings for machine and automotive parts.
6951	Si 0.20-0.50; Fe 0.8; Cu 0.15-0.40; Mn 0.10; Mg 0.40-0.8; Zn 0.20	S,W,B,E,T	Heat exchangers and cooling systems.
7001	Si 0.35; Fe 0.40; Cu 1.6-2.6; Mn 0.20; Mg 2.6-3.4; Cr 0.18-0.40; Zn 6.8-8.0; Ti 0.20	W,E,T	High strength alloy for aircraft structures.
7072	Si & Fe 0.7; Cu 0.10; Mn 0.10; Mg 0.10; Zn 0.8-1.3	W	Metallizing wire for sprayed, corrosion resistant coatings. Cladding alloy.
7075	Si 0.50; Fe 0.7; Cu 1.2-2.0; Mn 0.30; Mg 2.1-2.9; Cr 0.18-0.40; Zn 5.1-6.1; Ti 0.20	S,W,B,E,F,T	Aircraft structures and keys. High strength alloy.
Alclad 7075	(same as above)	S	Improved corrosion resistance over 7075.
7076	Si 0.40; Fe 0.6; Cu 0.30-1.0; Mn 0.30-0.8; Mg 1.2-2.0; Zn 7.0-8.0; Ti 0.20	F	Forgings, propeller blades.
7079	Si 0.30; Fe 0.40; Cu 0.40-0.8; Mn 0.10-0.30; Mg 2.9-3.7; Cr 0.10-0.25; Zn 3.8-4.8; Ti 0.10	E,F	Similar to 7075; preferred for heavy sections.
7178	Si 0.50; Fe 0.7; Cu 1.6-2.4; Mn 0.30; Mg 2.4-3.1; Cr 0.18-0.40; Zn 6.3-7.3; Ti 0.20	S,W,B,E	Very high strength structural alloy; aircraft applications.
Alclad 7178	(same as above)	S	Increased corrosion resistance over 7178.
7277	Si 0.50; Fe 0.7; Cu 0.8-1.7; Mg 1.7-2.3; Cr 0.18-0.35; Zn 3.7-4.3; Ti 0.10	Rivets and rivet rod	Large rivets that are hot driven. High strength applications.

NOTE: Other metals allowed for each alloy—each 0.05, total 0.15, except where noted.

*Be 0.0008 max for welding electrode and filler wire only.

Commercial forms: S—Sheets and plates. W—Wire. E—Extrusions. B—Bars. T—Tubes and pipe. F—Forgings and forging stock.

**Other alloys for impact extrusions: 2014, 2018, 2218, 3003, 4032, 5052, 6061, 6062, 6063, 6066, 7001, 7075, 7079.

ALUMINUM CASTING ALLOYS

Alloy	Composition Limits % max or range; Al remainder	Properties and Uses by Casting Type
12 (112 or 113) ASTM CS72A SAE 33 Federated 720	Cu 6.0-8.0; Fe 1.4; Si 1.0-4.0; Mn 0.6; Mg 0.10; Zn 2.5; Ti 0.25; Ni 0.35; others 0.50	Fair castability and good machinability. Early general purpose alloy. *Permanent Mold:* Vacuum cleaner housings, general purpose castings. *Sand:* Transmission housings, cover plates, manifolds, and miscellaneous machined castings.
13 ASTM S12B SAE 305 Federated 0120	Cu 0.6; Fe 1.3; Si 11.0-13.0; Mn 0.35; Mg 0.10; Zn 0.35; Ni 0.50; Sn 0.15; others 0.25	Excellent castability with good corrosion resistance. Good mechanical properties. General purpose alloy for large intricate parts with thin sections. *Die:* Typewriter frames, outboard motor pistons, dental equipment, instrument cases.
Apex Z33	Cu 2.5-3.5; Si 4.5-5.5; Mg 0.10; Zn 2.5-3.5; Fe 1.0; Mn 0.50; others 0.50	Good machinability, fair castability. Takes high polish. Similar to Z50. *Sand:* Household appliances, automotive, and miscellaneous machined parts.
Apex Z39	Cu 3.5-4.5; Si 8.5-9.5; Mg 0.1; Zn 1.5-2.5; Fe 1.2; Mn 0.5; Ni 0.5; others 0.4 each	Good castability and excellent machinability. *Die:* Automatic transmission impellers and housings, toys, brackets, and other castings where machining is required.
43 ASTM S5C SAE 35, 304 Federated 050	Cu 0.15; Fe 0.8; Si 4.5-6.0; Mn 0.35; Mg 0.05; Zn 0.35; Ti 0.25; others 0.05 each	Excellent castability and pressure tightness; good weldability and ductility, good corrosion resistance. *Permanent Mold:* Carburetor bodies, refrigerator shelf brackets and fittings, cooking utensils. *Sand:* Architectural and ornamental parts, pipe fittings, cooking utensils, food handling equipment and marine fittings. *Die:* Cookware, marine fittings.
Apex Z50	Cu 4.0-5.0; Si 2.5-3.5; Mg 0.07; Zn 1.5-2.5; Fe 1.0; Mg 0.6; Ni 0.3	Good machinability, fair castability. Takes high polish. *Sand:* Household appliances, automotive, and miscellaneous machined parts.
108 ASTM CS43A Apex 50 Federated 430	Cu 3.5-4.5; Fe 1.2; Si 2.5-3.5; Mn 0.50; Mg 0.10; Zn 1.0; Ti 0.25; Ni 0.35; others 0.50	General purpose alloy with fair castability. *Sand:* Manifolds, valve bodies, and similar castings.
A132 ASTM SN122A SAE 321 Federated 1121 Ni	Cu 0.50-1.5; Fe 1.3; Si 11.0-13.0; Mn 0.35; Mg 0.7-1.3; Zn 0.35; Ti 0.25; Ni 2.0-3.0; others 0.05	Good high temperature properties at 500 to 600° F. Low coefficient of thermal expansion. Weldability good. *Permanent Mold:* Pulleys and sheaves, automotive and diesel pistons.
F132 ASTM SC103A SAE 332	Cu 2.0-4.0; Fe 1.2; Si 8.5-10.5; Mn 0.50; Mg 0.5-1.5; Zn 1.0; Ni 0.50; Ti 0.25; others 0.5	Similar to A132 but with better castability and machinability.
138 ASTM CS104A Federated 1040.3	Cu 9.0-11.0; Fe 1.5; Si 3.5-4.5; Mn 0.6; Mg 0.15-0.35; Zn 1.5; Ti 0.25; Ni 1.0; others 0.50	High as-cast hardness; good castability and good machinability. *Permanent Mold:* Sole plates for electric hand irons.
142 (Y-alloy) ASTM CN42A SAE 39 A142 Federated 401.5 Ni	Cu 3.5-4.5; Fe 1.0; Si 0.7; Mn 0.35; Mg 1.2-1.8; Zn 0.35; Cr 0.25; Ti 0.25; Ni 1.7-2.3; others 0.15	Good strength at elevated temperatures. *Permanent Mold:* Aircraft generator housings, diesel and aircraft pistons, air cooled cylinder heads. *Sand:* Diesel engine pistons and air cooled cylinder heads.

Alloy	Composition Limits % max or range; Al remainder	Properties and Uses by Casting Type
Apex Red X 8 ASTM SC82A SAE 327	Cu 1.0-2.0; Si 7.0-8.5; Mg 0.2-0.6; Zn 1.0; Cr 0.3; Fe 1.0; Mn 0.2-0.6; others 0.2 each	Castability and mechanical properties good. Rugged, tough alloy for extreme applications. *Sand:* Cylinder blocks, crankcases, supercharger housings, and general automotive use.
Apex Red X 11	Cu 1.0-2.0; Si 10.5-11.8; Mg 0.4-1.0; Zn 1.0; Fe 0.9; Mn 0.5-0.9; others 0.2 each	Good castability with low coefficient of expansion. *Permanent Mold:* Automotive pistons and similar applications.
Apex Red X 20	Cu 1.0-2.0; Si 19-22; Mg 0.4-1.0; Mn 0.2-0.6; Ni 0.3-1.0; Fe 0.8; Zn 1.0	Excellent wear resistance, low coefficient of thermal expansion. *Sand, Permanent Mold,* and *Die:* Cylinders, liners, brakes, precision instruments.
152 Apex 66 ASTM C866A SAE 300 Federated 750.3	Cu 5.5-7.5; Fe 1.5; Si 5.0-6.0; Mn 0.8; Mg 0.20-0.6; Zn 0.8; Ti 0.25; others 0.8	Good elevated temperature strength and good machinability. *Permanent Mold:* Automotive pistons.
195 ASTM C4A SAE 38 Federated 410	Cu 4.0-5.0; Fe 1.0; Si 1.5; Mn 0.35; Mg 0.03; Zn 0.35; Ti 0.25; others 0.15	Castability fair with good machining properties. Good balance of mechanical properties for parts needing strength and ruggedness. *Sand:* Flywheel and rear axle housings, bus and aircraft wheels, spring hangers, fittings, crankcases; usually heat treated.
214 ASTM G4A SAE 320 Federated 004	Cu 0.15; Fe 0.50; Si 0.35; Mn 0.35; Mg 3.5-4.5; Zn 0.15; Ti 0.25; others 0.15	Castability poor; good balance of mechanical properties. Excellent corrosion and tarnish resistance. Good alloy for anodizing. *Sand:* Dairy and food handling equipment, cooking utensils, fittings for chemical and sewage use, hardware, and ornamental housings.
218 ASTM G8A Federated 008	Cu 0.25; Fe 1.8; Si 0.35; Mn 0.35; Mg 7.5-8.5; Zn 0.15; Ni 0.15; Sn 0.15; others 0.25	Good resistance to corrosion and tarnish. Excellent strength and ductility. Good for anodizing. *Die:* Parts requiring high strength, ductility and corrosion resistance, such as aircraft and marine fittings, conveyor units, hardware. Not best for intricate parts due to poor castability.
220 ASTM G10A SAE 324 Federated 0010	Cu 0.25; Fe 0.30; Si 0.25; Mn 0.15; Mg 9.5-10.6; Zn 0.15; Ti 0.25; others 0.15	Requires special foundry practice. Highest strength and elongation of any sand casting alloy when heat treated. Good machinability and corrosion resistance. *Sand:* Parts requiring strength and shock resistance: Aircraft fittings, levers, brackets. Not for use above 250° F.
319 ASTM SC64C SAE 329 Federated 460	Cu 3.0-4.5; Fe 1.2; Si 5.5-7.0; Mn 0.8; Mg 0.50; Zn 1.0; Ti 0.25; Ni 0.50; others 0.50	Excellent castability with good mechanical properties. *Sand:* Piano plates and frames, engine crankcases, oil pans, rear axle housings requiring leak tightness, general purpose uses.
A319 Apex Allcast 70 ASTM SC64B SAE 326	Cu 3.3-4.3; Fe 1.0; Si 5.5-7.0; Mn 0.50; Mg 0.10; Zn 1.0; Ti 0.25; Ni 0.35; others 0.50	Excellent castability, good mechanical properties. Pressure tightness good. *Sand:* Engine crankcases, oil pans, automatic transmission housings. *Permanent Mold:* Typewriter frames, engine parts.
333 SAE 331	Cu 3.0-4.5; Fe 1.2; Si 8.0-10.0; Mn 0.8; Mg 0.6; Zn 1.0; Ni 0.5; Ti 0.2; others 0.50	Excellent casting characteristics with good mechanical properties. *Permanent Mold:* General purpose castings, engine parts, gas meter housings and regulator parts.
355 (A-355) C355 (HP355) ASTM SC51A SAE 322 Federated 150.5	Cu 1.0-1.5; Fe 0.6; Si 4.5-5.5; Mn 0.50; Mg 0.45-0.60; Zn 0.35; Cr 0.25; Ti 0.25; others 0.15	Castability and weldability good. Pressure tightness good. Parts usually heat treated. *Permanent Mold:* Aircraft supercharger covers, impellers, fittings and timing gears. Meter parts and fuel pump bodies. *Sand:* Air compressor pistons, printing press bed plates, crankcases, water jackets, gear housings, electric motor fans and blowers. Widely used. A355 parts used at elevated temperatures. C355 and HP355 for higher strength and ductility.
356 A356 (HP356) ASTM SG70A SAE 323 Federated 070.3	Cu 0.25; Fe 0.60; Si 6.5-7.5; Mn 0.35; Mg 0.20-0.40; Zn 0.35; Ti 0.25; others 0.15	Castability and weldability good. Good pressure tightness and resistance to corrosion. Parts usually heat treated. *Permanent Mold:* Machine tool parts, handwheels, aircraft pump parts. *Sand:* Automotive transmission cases, flywheel housings, oil pans, rear axle housings, brackets, fittings, and pump bodies. A356 and HP356 for higher strength and ductility.
X 357	Cu 0.05; Si 7.0; Mg 0.5	High strength and good ductility after heat treatment. *Sand* and *Permanent Mold:* Highly stressed aircraft and missile structures, high velocity blowers and impellers.
364	Cu 0.20; Fe 1.5; Si 7.5-9.5; Mn 0.10; Mg 0.20-0.40; Zn 0.15; Ni 0.15; Cr 0.25-0.50; others 0.15	Excellent castability and mechanical properties. *Die:* High ductility castings where resistance to impact is important.
Apex Ternalloy 5 ASTM ZG32A SAE 311	Cu 0.20; Si 0.20; Mg 1.4-1.8; Zn 2.7-3.3; Cr 0.20-0.40; Fe 0.8; Mn 0.4-0.6; Ti 0.25; others 0.05 each	High strength and good elongation without heat treatment. Exceptional dimensional stability. Good brazing and welding alloy. *Sand:* Pipe fittings, wrenches, farm machinery, machine tool equipment, high pressure valves, and other high strength uses. *Permanent Mold:* Street lighting equipment, heavy duty brackets, tooling equipment, precision gages, castings for electronics.
Apex Ternalloy 7 ASTM ZG42A SAE 312	Cu 0.20; Si 0.20; Mg 1.8-2.4; Zn 4.0-4.5; Fe 0.8; Mn 0.40-0.6; Cr 0.20-0.40; Ti 0.25; others 0.05 each	Same as above but for parts needing less elongation and higher yield strength. *Sand* and *Permanent Mold:* Can be heat treated to high strength.
360 ASTM SG100B SAE 309 Federated 090.5	Cu 0.6; Fe 1.3; Si 9.0-10.0; Mn 0.35; Mg 0.40-0.6; Zn 0.50; Ni 0.50; Sn 0.15; others 0.25	Excellent castability. Mechanical properties and corrosion resistance good. *Die:* Aircraft, marine, and outboard motor parts, general purpose castings.
380 ASTM SC84B Apex 30 SAE 306 Federated 480	Cu 3.0-4.0; Fe 1.3; Si 7.5-9.5; Mn 0.50; Mg 0.10; Zn 1.0; Ni 0.50; Sn 0.35; others 0.50	Castability and mechanical properties good. Good machinability. *Die:* General purpose parts. Most widely used diecasting alloy.
384 ASTM SC114A Apex 39-11 SAE 303 Federated 4110	Cu 3.0-4.5; Fe 1.3; Si 10.5-12.0; Mn 0.50; Mg 0.10; Zn 1.0	Excellent for thin walls. *Die:* Wringer frames, toys, automatic transmissions, general purpose thin wall castings.
Apex 417 Almag ASTM GM70B	Cu 0.10; Si 0.20; Mg 6.2-7.5; Fe 0.25; Mn 0.10-0.25; Ti 0.10-0.25; others 0.05 each	High strength, exceptional ductility; good anodizing characteristics and machinability. *Sand:* C-clamps, brackets and machined parts requiring strength, machinability, corrosion resistance, polishing, and anodizing. *Permanent Mold:* Impellers, optical equipment needing high polish or anodizing finish.
A612 ASTM ZG61B SAE 313	Cu 0.35-0.65; Fe 0.50; Si 0.15; Mn 0.05; Mg 0.6-0.8; Zn 6.0-7.0; Ti 0.25; others 0.15	High strength and ductility without heat treatment. Good machinability. *Sand:* General purpose castings, particularly for brazing.
C612 ASTM ZC60A SAE 314	Cu 0.35-0.65; Fe 1.4; Si 0.35; Mn 0.05; Mg 0.25-0.45; Zn 6.0-7.0; Ti 0.25; others 0.15	High strength and ductility without heat treatment. Good machinability. *Permanent Mold:* Torque converter impeller blades and furniture parts requiring brazing.
Federated Tenzaloy ASTM ZC81A-B	Cu 0.40-1.0; Fe 1.0; Si 0.25; Mn 0.6; Mg 0.20-0.50; Zn 7.0-8.0; Cr 0.35; Ti 0.25; Ni 0.15; others 0.25	High strength without heat treatment. Ages at room temperature to give properties of heat treated castings. *Permanent Mold:* Machine tool frames, high speed fan rotors. *Sand:* Housings for hoists and other heavy duty equipment. Street signs and brackets. Excellent machinability, easily brazed.
40E ASTM ZG61A SAE 310	Cu 0.30; Fe 1.0; Si 0.25; Mn 0.30; Mg 0.50-0.65; Zn 5.2-6.0; Cr 0.40-0.60; Ti 0.10-0.25; others 0.25	Good mechanical properties without heat treatment. Good resistance to corrosion and shock. *Sand:* Aircraft and instrument parts subject to shock.
750	Cu 0.7-1.3; Fe 0.7; Mn 0.10; Si 0.7; Ni 0.7-1.3; Ti 0.20; Sn 5.5-7.0; others 0.30	Excellent bearing qualities with good compressive yield strength. *Permanent Mold* and *Sand:* Bearings, bushings, and parts needing bearing properties.
Federated Adaptaloy	Cu 2.0; Mn 1.0	Highly ductile alloy. Useful for castings that must be cold formed for assembly operation. Tensile, yield, and hardness are comparable to the 43 alloy.

ZINC DIECASTING ALLOYS

ASTM, SAE Number, and Commercial Name	Composition Limits % ASTM B86-57T Specification	Outstanding Properties	Typical Applications
AG40A SAE-903 Zamak-3	Cu 0.25 max; Al 3.5-4.3; Mg 0.03-0.08; Fe 0.100 max; Pb 0.007 max; Cd 0.005 max; Sn 0.005 max	Retention of impact strength and dimensions. Used where stability is important.	Carburetors, fuel pumps, refrigerator hardware, washing machines, parking meters, television, any of below.
AC41A SAE-925 Zamak-5	Cu 0.75-1.25; Al 3.5-4.3; Mg 0.03-0.08; Fe 0.100 max; Pb 0.007 max; Cd 0.005 max; Sn 0.005 max	Greater hardness and tensile strength. Used where hardness is important.	Business machines, gears, cams, hardware, lawn mowers, fans, small tools, any of above.

ZIRCONIUM

Material	Nominal Composition %	Properties and Applications
Commercial Grade	Hf 2.5	Ductile and formable. Chemical processing equipment, fittings, heat exchangers. Highly resistant to bases and acids, except hydrofluoric. Fusion weldable in inert atmospheres.
Reactor Grade	Hf 200 ppm max	Ductile and formable. Low cross section for nuclear uses. Also used as filament for flash bulbs.
Zircaloy-2	Sn 1.5; Cr 0.1; Fe 0.13; Ni 0.05	Ductile and formable. Low cross section for nuclear uses. Resists steam corrosion.
Zircaloy-3	Sn 0.25; Fe 0.25	Ductile and formable. Used for core material in nuclear reactors.

Note: Zirconium alloys are available as rolled flat products, bars and billets, extrusions, wire, tubes (welded and seamless), and forgings.

BERYLLIUM-BEARING ALLOYS

Producers' Designations: Brush Beryllium Co.	Producers' Designations: Beryllium Corp.	Nominal Composition %	Properties and Applications
CASTING ALLOYS			
Beryllium Copper Master	Beryllium Copper Master	Be 3.50-4.50	Used as a source of beryllium in compounding alloys.
Beryllium Aluminum Master		Be 4.00-6.00; Mg 0.50 max; Al bal	Used as a source of beryllium in compounding alloys.
	Beryllium Aluminum Master	Be 4.00-6.00; Mg 1.00 max; Al bal	Used as a source of beryllium in compounding alloys.
	Beryllium Magnesium Aluminum Master	Be 5.00; Mg 3.00; Al bal	Used as a source of beryllium in compounding alloys.
35 C		Be 0.25-0.50; Ni 1.40-1.60; Cu bal	High conductivity, heat treatable alloy for resistance welding dies and electrodes. Meet RWMA Class 3 specifications.
10 C	10-CR	Be 0.55-0.75; Co 2.40-2.60; Cu bal	High conductivity, heat treatable alloy with moderate strength and hardness. Maintains conductivity and hardness to 700° F. Circuit breaker and switch parts, resistance welding electrodes, butt-welding and projection welding dies. Meets RWMA Class 3 specifications.
20 C	20-CR	Be 2.00-2.25; Co 0.35-0.65; Cu bal	Heat treatable alloy with good fluidity, low pouring temperature, excellent wear and corrosion resistance, high strength. Bearings, gears, cams, valve and pump parts, drawing dies.
	50-CR	Be 0.50; Co 1.55; Ag 1.10; Cu bal	High conductivity alloy for resistance welding dies and electrodes. Good hardness and strength, low surface contact resistance, resists oxidation at elevated temperatures. Meets RWMA Class 3 specifications.
240 C		Be 2.35-2.55; Ni 1.00-1.20; Cu bal	Heat treatable alloy which has the highest strength of copper-base alloys. Provides excellent mechanical properties with moderate conductivity.
275 C	275-CR	Be 2.60-2.85; Co 0.35-0.65; Cu bal	Heat treatable alloy with maximum hardness and wear resistance. Used in plastic molds, deep drawing dies.
260 C		Be 2.55-2.80; C 0.40 max; Ni bal	Heat treatable alloys with excellent castability, extremely high strength and hardness, and good corrosion resistance. Used in turbine wheels, glass molds, plastic compression molds, valve bodies, and wrench jaws.
220 C		Be 2.00-2.30; C 0.40 max; Ni bal	
WROUGHT ALLOYS*			
25	25	Be 1.80-2.05; Co 0.20-0.30; Cu bal	These alloys in strip form can be blanked, formed, deep drawn, or spun, then heat treated to provide maximum mechanical properties. They also can be supplied in a mill hardened condition for limited forming operations. Uses include springs, diaphragms, bellows, electronic parts, bearings, gears, torsion bars, electrical connectors.
165	165	Be 1.60-1.80; Co 0.20-0.30; Cu bal	
	50	Be 0.50; Co 1.55; Ag 1.00; Cu bal	High conductivity alloy, good hardness and strength, resists oxidation at elevated temperatures. Bearings, gears, torsion bars, electrical connectors.
10	10	Be 0.40-0.60; Co 2.40-2.60; Cu bal	These alloys in the form of plates, bars, and forgings are used for welding dies, bus bars, plastic mold parts, and drawing dies.
35		Be 0.25-0.50; Ni 1.40-1.60; Cu bal	
	Beryldur	Be 1.00; Co 0.25; Others 4.00; Cu bal	A moderate strength alloy with the same uses as 25 and 165 alloys.

*All the Brush Beryllium Co. wrought alloys are supplied as billets, plates, bars, and strip including the trademarked Pennrold Precision Strip. Beryllium Corp. Alloy 165 and Beryldur are available in sheets and strip. Alloy 50 is supplied in rods, bars, and billets. Alloys 10 and 25 are available as billets, plates, sheets and strip, rods, and bars. Alloy 25 is also supplied in wire form.

HIGH STRENGTH STEELS

Name	Producer	Chemical Composition Limits, Per Cent C	Mn	P	S	Si	Cu	Mo	Cr	Ni	Others	Yield Point Min psi	Tensile Strength Min psi	% Elongation in 2 in. for Stand. ASTM Spec.
Algo-Loy 1315	Algoma Steel Corp. Ltd.	0.10–0.20	1.10–1.65	0.045 max	0.050 max	0.15–0.35	0.40 max	.....	.....	.....	.....	50,000	70,000	22
Algo-Loy 1316	Algoma Steel Corp. Ltd.	0.22 max	1.25 max	0.080 max	0.050 max	0.35 max	0.20 min	0.05 max	0.40 max	0.40 max	V 0.05 max	50,000	70,000	20
Algo-Loy 1317	Algoma Steel Corp. Ltd.	0.25 max	1.65 max	0.045 max	0.050 max	0.35 max	0.20 min	0.05 max	0.30 max	0.30 max	.....	50,000	70,000	20
Cor-Ten	United States Steel Corp., Acme Steel Co., Algoma Steel Corp. Ltd., Crucible Steel Co. of America, Greer Steel Co., Inland Steel Co., Lukens Steel Co., Republic Steel Corp., Sharon Steel Corp.	0.12 max	0.20–0.50	0.07–0.15	0.05 max	0.25–0.75	0.25–0.55	.....	0.30–1.25	0.65 max	.....	50,000	70,000	22
Clay-Loy	Colorado Fuel & Iron Corp.	0.22 max	1.25 max	0.05 max	0.05 max	0.35 max	0.50 max	.....	.....	.....	V 0.02 min	50,000	70,000	..
Dynalloy	Alan Wood Steel Co.	0.15 max	0.60–1.00	0.05–0.10	0.05 max	0.30 max	0.30–0.60	0.05–0.15	.....	0.40–0.70	.....	50,000	70,000	25
GLX-45-W	Great Lakes Steel Corp.	0.10–0.20	0.50–1.00	0.04 max	0.05 max	0.10 max	.....	.....	.....	.....	Cb 0.10–0.40	45,000	65,000	22
GLX-50-W	Great Lakes Steel Corp.	0.10–0.20	0.50–1.00	0.04 max	0.05 max	0.10 max	.....	.....	.....	.....	Cb 0.10–0.40	50,000	70,000	22
GLX-55-W	Great Lakes Steel Corp.	0.10–0.20	0.50–1.00	0.04 max	0.05 max	0.10 max	.....	.....	.....	.....	Cb 0.10–0.40	55,000	75,000	22
GLX-60-W	Great Lakes Steel Corp.	0.10–0.20	0.50–1.00	0.04 max	0.05 max	0.10 max	.....	.....	.....	.....	Cb 0.10–0.40	60,000	80,000	22
Hi-Steel	Inland Steel Co.	0.12 max	0.50–1.00	0.12 max	0.05 max	0.15 max	0.55–1.30	0.18 max	.....	0.30–0.75	.....	50,000	70,000	22 (1)
Hi-Man	Inland Steel Co.	0.25 max	1.10–1.60	0.045 max	0.05 max	0.30 max	0.20 min	.....	.....	.....	.....	50,000	75,000	20
High Strength #1	Armco Steel Corp.	0.15 max	0.40–0.95	0.04–0.07	0.04 max	0.15 max	0.50–0.75	.....	.....	0.60–0.90	.....	50,000	70,000	22
High Strength #2	Armco Steel Corp.	0.15 max	0.40–0.95	0.04–0.07	0.04 max	0.15 max	0.50–0.75	.....	.....	0.60–0.90	.....	45,000 typ.	64,000 typ.	..
High Strength #3	Armco Steel Corp.	0.10 max	0.30–0.90	0.04 max	0.05 max	0.10 max	0.20 max	.....	.....	.....	V 0.02 min	40,000 typ.	60,000 typ.	35 typ.
High Strength #4	Armco Steel Corp.	0.25 max	1.10–1.60	0.045 max	0.05 max	0.15–0.35	0.20 min	.....	.....	.....	.....	50,000	70,000	22
Jalten #1	Jones & Laughlin Steel Corp.	0.15 max	1.30 max	0.04 max	0.05 max	0.10 max	0.30 min	.....	.....	.....	V 0.035–0.065	50,000	65,000	22
Jalten #2	Jones & Laughlin Steel Corp.	0.15 max	1.40 max	0.14 max	0.05 max	0.10 max	0.30 min	.....	.....	.....	.....	50,000	70,000	22
Jalten #3-S	Jones & Laughlin Steel Corp.	0.25–0.31	1.35–1.65	0.04 max	0.05 max	0.30 max	0.20 min	.....	.....	.....	.....	50,000	70,000	22
Jalten #3-R	Jones & Laughlin Steel Corp.	0.25–0.31	1.35–1.65	0.04 max	0.05 max	0.15–0.30	0.20 min	.....	.....	.....	.....	50,000	70,000	22
Jalloy #1	Jones & Laughlin Steel Corp.	0.13–0.18	1.00–1.30	0.04 max	0.04 max	0.15–0.30	0.20 min	0.10–0.20	.....	.....	.....	60,000	80,000	23
Jalloy #3	Jones & Laughlin Steel Corp.	0.25–0.31	1.35–1.65	0.04 max	0.04 max	0.15–0.30	0.20 min	0.10–0.20	.....	.....	.....	100,000	115,000	18 (4) (5)
Kaisaloy #1	Kaiser Steel Corp.	0.20 max	1.25 max	0.05 max	0.05 max	0.60 max	0.35 max	0.15 max	0.25 max	0.60 max	V 0.02 min Ti 0.005 min Al 0.25 max	50,000	70,000	23
Kaisaloy #2	Kaiser Steel Corp.	0.12 max	0.60 max	0.04 max	0.04 max	0.50 max	0.30 max	0.10 max	0.25 max	0.60 max	V 0.02 min Ti 0.005 min	45,000	60,000	25
Kaisaloy #3	Kaiser Steel Corp.	0.30 max	1.50 max	0.04 max	0.05 max	0.35 max	0.35 max	0.10 max	0.25 max	0.40 max	V 0.05 min Ti 0.005 min	.....	.....	..
Kaiser Structural High Strength Steel	Kaiser Steel Corp.	0.27 max	1.60 max	0.045 max	0.05 max	0.30 max	0.20 max	.....	.....	.....	.....	50,000	75,000	18
Man-Ten	United States Steel Corp.	0.25 max	1.00–1.60	0.045 max	0.05 max	0.30 max	0.20 min	.....	.....	.....	.....	50,000	75,000	20
Maxeloy	Crucible Steel Co. of America	0.15 max	1.20 max	0.07 max	0.04 max	0.50 max	0.20 min	.....	.....	0.50 max	.....	50,000	70,000	22
Mayari R	Bethlehem Steel Co.	0.12 max	0.50–1.00	0.12 max	0.05 max	0.20–0.90	0.50 max	.....	0.40–1.00	1.00 max	Zr 0.10 max	50,000	70,000	22
Medium Manganese	Bethlehem Steel Co.	0.25 max	1.10–1.60	0.04 max	0.05 max	0.30 max	0.20–0.35	.....	.....	.....	.....	50,000	75,000	20
Manganese Vanadium	Bethlehem Steel Co.	0.22 max	1.25 max	0.04 max	0.05 max	0.30 max	0.20 min	.....	.....	.....	V 0.02 min	50,000	70,000	22
N-A-X High Tensile	Great Lakes Steel Corp., Republic Steel Corp., Sharon Steel Corp., Granite City Steel Co. (2)	0.15 max	0.50–1.00	0.04 max	0.05 max	0.60–0.90	0.25 max	0.20 max	0.40–0.70	.....	Zr 0.05–0.15	50,000	70,000	22
N-A-X Finegrain (3)	Great Lakes Steel Corp.	0.18 max	0.50–1.00	0.04 max	0.05 max	0.50–0.90	0.25 max	.....	.....	.....	Zr 0.05–0.15	50,000	70,000	22
N-A-X High Manganese	Great Lakes Steel Corp.	0.25 max	1.10–1.60	0.045 max	0.05 max	0.30 max	0.20 min	.....	.....	.....	.....	50,000	70,000	22
N-A-Xtra 80	Great Lakes Steel Corp.	0.10–0.20	0.60–1.00	0.040 max	0.040 max	0.50–0.90	.....	0.15–0.25	0.45–0.85	.....	Zr 0.03–0.15	80,000	85,000	18 (4)
N-A-Xtra 90	Great Lakes Steel Corp.	0.10–0.20	0.60–1.00	0.040 max	0.040 max	0.50–0.90	.....	0.15–0.25	0.45–0.85	.....	Zr 0.03–0.15	90,000	105,000	18 (4)
N-A-Xtra 100	Great Lakes Steel Corp.	0.10–0.20	0.60–1.00	0.040 max	0.040 max	0.50–0.90	.....	0.15–0.25	0.45–0.85	.....	Zr 0.03–0.15	100,000	115,000	18 (4)
N-A-Xtra 110	Great Lakes Steel Corp.	0.10–0.20	0.60–1.00	0.040 max	0.040 max	0.50–0.90	.....	0.15–0.25	0.45–0.85	.....	Zr 0.03–0.15	110,000	125,000	18 (4)
N-A-Xtra Abrasion Resistant (6)	Great Lakes Steel Corp.	0.25–0.31	0.60–1.00	0.040 max	0.040 max	0.50–0.90	.....	0.15–0.25	0.45–0.85	.....	Zr 0.03–0.15	165,000	180,000	16 (4)

(Continued on Page S-30)

HIGH STRENGTH STEELS (continued)

Name	Producer	Chemical Composition Limits, Per Cent C	Mn	P	S	Si	Cu	Mo	Cr	Ni	Others	Yield Point Min psi	Tensile Strength Min psi	% Elongation in 2 in. for Stand. ASTM Spec.
Par-Ten	United States Steel Corp.	0.12 max	0.75 max	0.03 max	0.04 max	0.10 max	.....	.....	.....	.....	V 0.01–0.07	45,000 typ.	62,000 typ.	28 typ.
Republic "50"	Republic Steel Corp.	0.15 max	0.50–1.00	0.04 max	0.05 max	.....	0.30–1.00	0.10 min	0.30 max	0.40–1.10	.....	50,000	70,000	22
Republic "M"	Republic Steel Corp.	0.25 max	1.10–1.60	0.045 max	0.05 max	0.30 max	0.20 min	.....	.....	.....	.....	50,000	70,000	20
Republic "65"	Republic Steel Corp.	0.15 max	1.00 max	0.04 max	0.04 max	0.15 max	0.90–1.40	0.20–0.30	.....	1.00–1.50	.....	65,000	85,000	20 (4)
Republic "70"	Republic Steel Corp.	0.20 max	1.00 max	0.04 max	0.04 max	0.15 max	1.00–1.50	0.20–0.30	.....	1.20–1.75	.....	70,000	90,000	18 (4)
Stelcoloy "A"	Steel Co. of Canada Ltd.	0.10	1.10	0.02	0.03	0.20	0.35	.....	0.50	0.50	.....	50,000	70,000	22
Stelcoloy "B"	Steel Co. of Canada Ltd.	0.10	0.45	0.08	0.03	0.45	0.35	.....	0.50	0.50	.....	50,000	70,000	22
Strenlite	Steel Co. of Canada Ltd.	0.27 max	1.10–1.60	0.04 max	0.05 max	0.30 max	0.20 min	.....	.....	.....	.....	50,000	70,000	22
Tri-Steel	Inland Steel Co.	0.22 max	1.25 max	0.04 max	0.05 max	0.30 max	0.20 min	.....	.....	.....	V 0.02 min	50,000	70,000	22
Tri-Ten	United States Steel Corp.	0.22 max	1.25 max	0.040 max	0.05 max	0.30 max	0.20 min	.....	.....	.....	V 0.02 min	50,000	70,000	22
"T-1"	United States Steel Corp., Lukens Steel Co.	0.15	0.80	0.040 max	0.050 max	0.25	0.30	0.50	0.60	0.85	V 0.05 B 0.004	100,000	115,000	18
U.S.S. Cu-Ni-Mo	United States Steel Corp.	0.21 max	0.80–1.10	0.04 max	0.05 max	0.15–0.30	0.50–0.80	0.20–0.30	.....	1.20–1.50	.....	65,000	140,000	18 (4)
Yoloy	Youngstown Sheet & Tube Co.	0.15 max	0.75 max	0.10 max	0.05 max	0.30 max	0.75–1.25	.....	.....	1.50–1.85	.....	50,000	70,000	22 (1)
Yoloy B	Youngstown Sheet & Tube Co.	0.12 max	0.75 max	0.04 max	0.05 max	0.10 max	.....	.....	.....	.....	V 0.01–0.07	45,000	62,000	28
Yoloy E	Youngstown Sheet & Tube Co.	0.18 max	0.90 max	0.10 max	0.05 max	.....	0.20–0.50	0.40 max	0.20–0.35	0.40–1.00	.....	50,000	70,000	22
Yoloy M Grade A	Youngstown Sheet & Tube Co.	0.25 max	1.60 max	.....	.....	0.30 max	Optional	.....	.....	.....	.....	50,000	75,000	20
Yoloy M Grade B	Youngstown Sheet & Tube Co.	0.23 max	1.40 max	.....	.....	0.15–0.30	0.20 min	.....	.....	.....	.....	45,000	70,000	22
Yoloy S	Youngstown Sheet & Tube Co.	0.12 max	0.60 max	0.04 max	0.05 max	0.030 max	0.75–1.25	.....	.....	1.65–2.00	.....	65,000	95,000	20 (4)

(1) Steels with copper over a minimum of 0.60 will respond to precipitation hardening, resulting in a higher strength level, depending on time-temperature cycle performed.
(2) Licensed; not presently producing.
(3) All licensees for N-A-X High Tensile are also licensed to produce N-A-X Finegrain.
(4) Heat treatment required to meet tensile properties shown.
(5) Jalloy #3 is also produced to Brinell hardness grades of 280, 320, 360, and 400 for abrasion and impact resistant applications.
(6) N-A-Xtra Abrasion Resistant Steel is normally supplied to a Brinell hardness range of 363 to 400.

PROPERTIES AND TYPICAL APPLICATIONS: Strength of the high strength, low alloy steels as measured by their yield point is about 50 per cent higher than structural carbon steel. Yield points of the alloy and high strength grades are even higher. Working stress in tension can be more than 50 per cent greater. Besides higher yield strengths, they have good corrosion, abrasion, and fatigue resistance and can be fabricated by usual methods. Some applications: Tanks, trailers, trucks, material handling equipment, auto frames, wheels and bumpers, railroad cars, pole line hardware, earth moving equipment, mine cars, agricultural equipment, bridges, buckets, LPG cylinders, screens, towers, booms, cranes, dipper sticks, locomotive parts, mobile lifting equipment, portable military bridges, canal locks, gates and dams, lampposts, auto jacks, cable reels, stokers, furnace bodies, cabinets, and re-usable shipping containers.

SUPERSTRENGTH STEELS

Material	Nominal Composition %	Tensile Strength—psi
SAE 4130	C 0.30; Mn 0.50; Si 1.30; Cr 0.95; Mo 0.20	200,000 to 240,000
SAE 4330 modified with Vanadium (AMS 6427)	C 0.30; Mn 0.90; Si 0.30; Ni 1.80; Cr 0.85; Mo 0.45; V 0.05-0.10	220,000 to 240,000
AMS 6428	C 0.35; Mn 0.70; Si 0.30; Ni 1.80; Cr 0.80; Mo 0.35	220,000 to 240,000
SAE 4335 V (AMS 6434)	C 0.35; Mn 0.70; Si 0.30; Cr 0.85; Ni 1.85; Mo 0.35; V 0.20	210,000 to 260,000
SAE 4340 (AMS 6415)	C 0.40; Mn 0.65; Si 0.30; Cr 0.80; Ni 1.80; Mo 0.25	260,000 to 280,000
Timken 4741	C 0.36-0.44; Mn 0.60-0.90; P 0.040 max; S 0.040 max; Si 0.40-0.60; Cr 0.75-1.10; Ni 0.70-1.00; Mo 0.30-0.40	300,000 max
300-M Ultrahigh Strength Steel	C 0.40; Mn 0.70; Si 1.60; Ni 1.90; Cr 0.90; Mo 0.45; V 0.07	280,000 to 300,000
U. S. Steel Air Steel X-200	C 0.43; Mn 0.85; Si 1.50; Cr 2.00; Mo 0.50; V 0.05	280,000 min
U. S. Steel USS Strux (Mod. 98BV40)	C 0.35-0.40; Mn 0.85; Si 0.70; Ni 0.80; Cr 0.75; Mo 0.50; V 0.06; B 0.0015	260,000 to 280,000

SAE 4360	C 0.60 version of 4340	280,000 to 300,000
SAE 8620	C 0.20; Mn 0.80; Si 0.30; Cr 0.50; Ni 0.55; Mo 0.20	Carburized for increased strength.
SAE 8740	C 0.40; Mn 0.90; Si 0.30; Cr 0.50; Ni 0.55; Mo 0.25	210,000 to 260,000
SAE 9310	C 0.10; Mn 0.55; Si 0.30; Cr 1.25; Ni 3.25; Mo 0.12	Carburized for increased strength.
Bedco Alloy	C 0.55; Mn 1.00; Si 2.00; Mo 0.40; V 0.35	325,000 to 350,000
Crucible HY-Tuf (AMS 6418)	C 0.25; Mn 1.30; Si 1.50; Ni 1.80; Mo 0.40	230,000
Crucible UHS-260	C 0.35; Mn 1.25; Si 1.85; Cr 1.25; V 0.20; Mo 0.35	260,000 min
D6C	C 0.46; Mn 0.75; Si 0.25; Cr 1.05; Ni 0.55; Mo 1.00	220,000 to 280,000
Firth Sterling HWD #2	C 0.37; Cr 5.25; Mo 1.30; Si 1.00; V 0.50	220,000 to 290,000
Timken H.S. 220 (AMS 6407)	C 0.30; Mn 0.70; Si 0.60; Ni 2.05; Cr 1.20; Mo 0.45	220,000 to 240,000
Timken H.S. 260	C 0.40; Mn 0.70; Si 0.60; Cr 1.20; Ni 2.05; Mo 0.45	260,000 to 280,000
U. S. Steel USS Strux (Mod. 98BV40) AMS 6423	C 0.40-0.45 version of above	280,000 to 300,000
5CrMoV Aircraft Steel (Modified H-11) VascoJet 1000 Crucible 218 Potomac A Dynaflex Unimach I	C 0.40; Si 0.90; Cr 5.00; Mo 1.30; V 0.50	220,000 to 300,000
Unimach II	C 0.50; Mn 0.40; Si 1.00; Cr 5.00; Ni 1.50; Mo 1.40; V 1.00	220,000 to 310,000

APPLICATIONS: In their appropriate tensile strength ranges, these steels are designed to provide the maximum usable strength where minimum weight is of primary importance. Such uses are in aircraft landing gear and airframe components, wing pylon parts and fasteners, wing attachment fittings, and superstrength bolts. Other applications: Sheet or plate parts for supersonic speeds, pressure vessels for aircraft use, oil well perforating guns and carbide bit bodies. Examples of other constructional parts are axles, gears, and shafting of all types. Although the acceptance of many of these superstrength steels will be a gradual process, today's trend toward machines and equipment operating at higher and higher stress levels will increase their ultimate use in many ways.

TITANIUM

Material (nominal composition)	Specifications AMS	Military	ASTM	Producers' Designations	Mill Forms	Tensile Strength (psi)	Yield Strength (psi)	Elong. (%)	R. A. (%)	Properties and Applications
Unalloyed				Ti-35A	S,B,E,W,T	35,000	25,000	25	35	Special soft grade for uses where structural strength is less important than corrosion resistance. Heat exchangers.
Unalloyed	4902		B-265-58T B-348-59T B-338-58T B-337-58T	MST-30 Ti-45A	S,B,E,W,T	45,000	35,000	22	35	Valves, heat exchangers, dished heads, and similar uses where corrosion resistance is an important design consideration.
Unalloyed	4902 4941 4951	Mil-T-9047B	B-265-58T B-348-59T B-338-58T B-337-58T	MST-40 RS-40 A-40 Ti-55A	S,B,E,W,T	65,000	50,000	28	50	Nonstructural aircraft and corrosion uses where ductility and formability are needed. Fusion weldable. Processing equipment, fittings, heat exchangers, valve trim, marine uses.
Unalloyed	4900A	Mil-T-9046C Mil-T-9047B	B-265-58T B-348-59T B-338-58T B-337-58T	MST-55 RS-55 A-55 Ti-65A	S,B,E,W,T	80,000	65,000	25	50	Properties and uses same as above except it has higher strength. Used as rods and wire for welding other titanium alloys; anodizing racks.
Unalloyed	4901B 4921B	Mil-T-9047B Mil-T-9046C	B-265-58T B-338-58T B-337-58T	MST-70 RS-70 A-70 Ti-75A	S,B,E,W,T	90,000	80,000	20	40	Used for same purposes as above grades, but where higher strengths are needed with some sacrifice in ductility and formability. Aircraft nacelles, webs, stiffeners, angles, shrouds, fire walls, fasteners, engine rings, ammunition boxes, gun blast panels, shroud spacers, anodizing racks.
Unalloyed	4921B	Mil-T-9047B	B-348-59T	Ti-100A	B	80,000	70,000	15	30	Properties and uses same as above.
Alpha Titanium Alloys 5Al-2.5Sn	4910 49-AB 4926 4966 4953	Mil-T-9046B Mil-T-9047B	B-265-58T B-348-59T	MST-5Al-2.5Sn RS-110C A-110AT Ti-5Al-2.5Sn	S,B,W,F	125,000	115,000	18	40	Forgings and welded sheet assemblies where creep resistance up to 900° F is required. Aircraft engine compressor case housings, tail cones, shroud spacers, stiffeners, high strength fusion welded assemblies.
6Al-4Zr-1V				Ti-6Al-4Zr-1V	S	143,000	138,000	17		Development alloy. Comparable in properties and applications to the 5Al-2.5Sn alloy.
8Al-1Mo-1V				Ti-8Al-1Mo-1V	S,B	147,000	135,000	16		High temperature jet engine forging alloy. Useful for airframes where creep properties of other alloys are not good enough at elevated temperatures. Extends temperature range about 150° F over alloys like 6Al-4V.

(Continued on Page S-32)

TITANIUM (continued)

Material (nominal composition)	Specifications AMS	Specifications Military	Specifications ASTM	Producers' Designations	Mill Forms	Tensile Strength (psi)	Yield Strength (psi)	Elong. (%)	R.A. (%)	Properties and Applications
8Al-2Cb-1Ta				MST-821	S,B,E,W,F	135,000	125,000	15	40	Compressor blades, fire walls, tail cones, stiffeners, welded assemblies. High strength forgings. Has exceptional high temperature strength—about 200° F advantage in the 400 to 1000° F range.
8Al-8Zr-1(Cb+Ta)				MST-881	B	140,000	125,000	16		Present bar applications extend temperature range to 1100° F long time usage, 1600° F short time usage.
ALPHA-BETA TITANIUM ALLOYS										
3Al-2.5V				MST-3Al-2.5V	S,E,T	100,000	85,000	15		Highly weldable; particularly suitable for fabricating into welded and seamless tubing. May be hardened after forming to ultimate strength of 120,000 to 130,000 psi.
3Al-5Cr	4927	Mil-T-9047B		MST-3Al-5Cr	B,F	145,000	135,000	13	35	Aircraft forgings; fasteners.
2Fe-2Cr-2Mo	4923	Mil-T-9047B		Ti-140A	S,B,F	130,000	115,000	15	25	Airframes, skins.
8Mn	4908A	Mil-T-9046C	B-265-58T	MST-8Mn RS-110A C-110M	S	130,000	120,000	15		For medium, high strength, sheet uses where good formability is needed. Not used for fusion welded assemblies or above 650° F. Longerons, bulkheads, channels, stressed skins, and frames.
4Al-4Mn	4925A	Mil-T-9047B		MST-4Al-4Mn RS-130 C-130AM	B,W,F	145,000	133,000	15	40	High strength airframe and engine forgings and fasteners where good weld ductility is not needed. Industrial equipment requiring maximum strength with good corrosion and erosion resistance.
4Al-3Mo-1V*				MST-431 RS-115 C-115AMoV Ti-4Al-3Mo-1V	S	133,000	123,000	11		Heat treatable sheets with good formability in solution condition. To get 155,000 psi yield strength, heat treat at 1650° F, water quench, and age at 925° F for 12 hours.
4Al-4Mo-4V				Ti-4Al-4Mo-4V	B	170,000	150,000	6		Development alloy. Fastener material for aircraft.
5Al-2.75Cr-1.25Fe*				RS-140	B,S	158,000	147,000	16	40	High strength forgings and sheet parts. Heat treatment increases tensile strength to 180,000 psi with corresponding increase in yield strength.
5Al-1.5Fe-1.4Cr 1.2Mo	4929 4969	Mil-T-9047B		Ti-155A	B	145,000	135,000	10	20	Heat treatable forging stock for aircraft parts. Heat treatment gives average yield strength of 173,000, tensile strength of 180,000 psi. Heat treat capability guaranteed to 170,000 psi.
6Al-4V*	4928 4911	Mil-T-9046C Mil-T-9047B	B-265-58T	MST-6Al-4V RS-120A C-120AV Ti-6Al-4V	S,B,E,W,F	145,000	130,000	13	40	Medium high strength aircraft and engine forgings. Ordnance equipment where good elevated temperature strength and stability are needed with good machinability. Compressor wheels and blades, spacers.
7Al-4Mo*				MST-7Al-4Mo RS-135 C-135AMo Ti-7Al-4Mo	B,E,T	145,000	135,000	10	20	Heat treatable forging alloy combines good creep resistance, stress stability, and high temperature strength. Used in aircraft turbines for compressor wheels and blades, hub-shafts, and spacer rings.
2.5Al-16V*				MST-2.5Al-16V	B,S,W	175,000**	160,000	6		Airframe skins, webs, angles, and shrouds, fasteners. Age hardened parts have good short time hot strength (yield strength about 100,000 psi up to 800° F). Sheets are heat treatable with good formability in solution treated condition.
BETA TITANIUM ALLOYS										
13V-11Cr-3Al				RS-120B B-120VCA Ti-13V-11Cr-3Al	S,B,W	125,000	120,000	10		Weldable, heat treatable alloy for solid propellent pressure casings. Cold rolled and aged sheet provides tensile strengths in excess of 210,000 psi.

*Indicates response to heat treatment. **Age hardened. ***Vacuum annealed.
S—Sheets, strip, plates. E—Extrusions. T—Tubes.
B—Bars and billets. F—Forgings. W—Wire.

Producers' designations:
MST—Mallory-Sharon Metals Corp., Niles, Ohio.
RS—Republic Steel Corp., Massillon, Ohio.
A, B, and C—Crucible Steel Co. of America, Midland, Pa.
Ti—Titanium Metals Corp. of America, New York.

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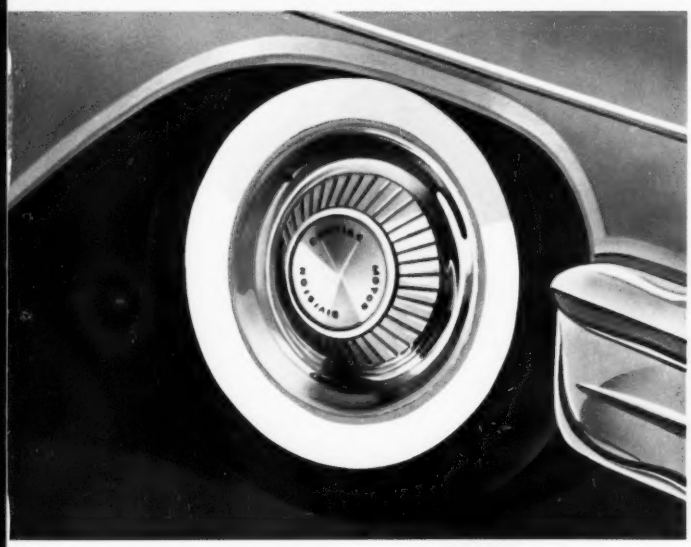
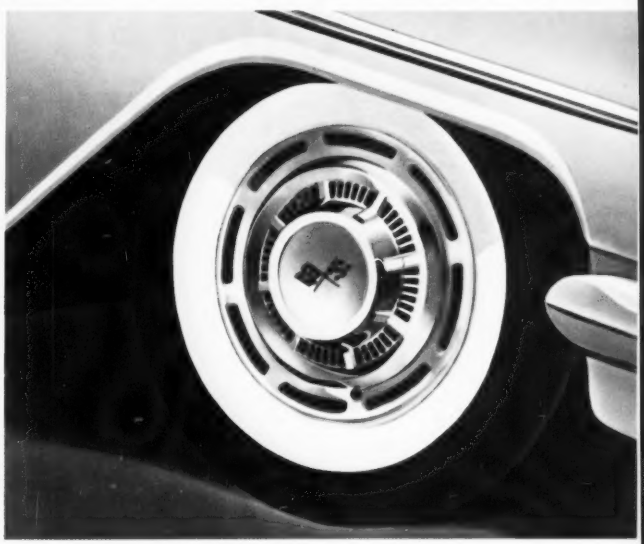
Leadership demands the best in performance . . . and only stainless steel will do for the gleaming wheel covers of leading cars. We are most proud that SUPERIOR Stainless Strip Steel is used in the fabrication of wheel covers by Brown-Lipe-Chapin. Every stainless quality is in our product, plus the finer forming behavior that is traditionally Superior. Let us discuss your stainless strip requirements.





SUPERIOR STEEL DIVISION

OF

COPPERWELD STEEL COMPANY

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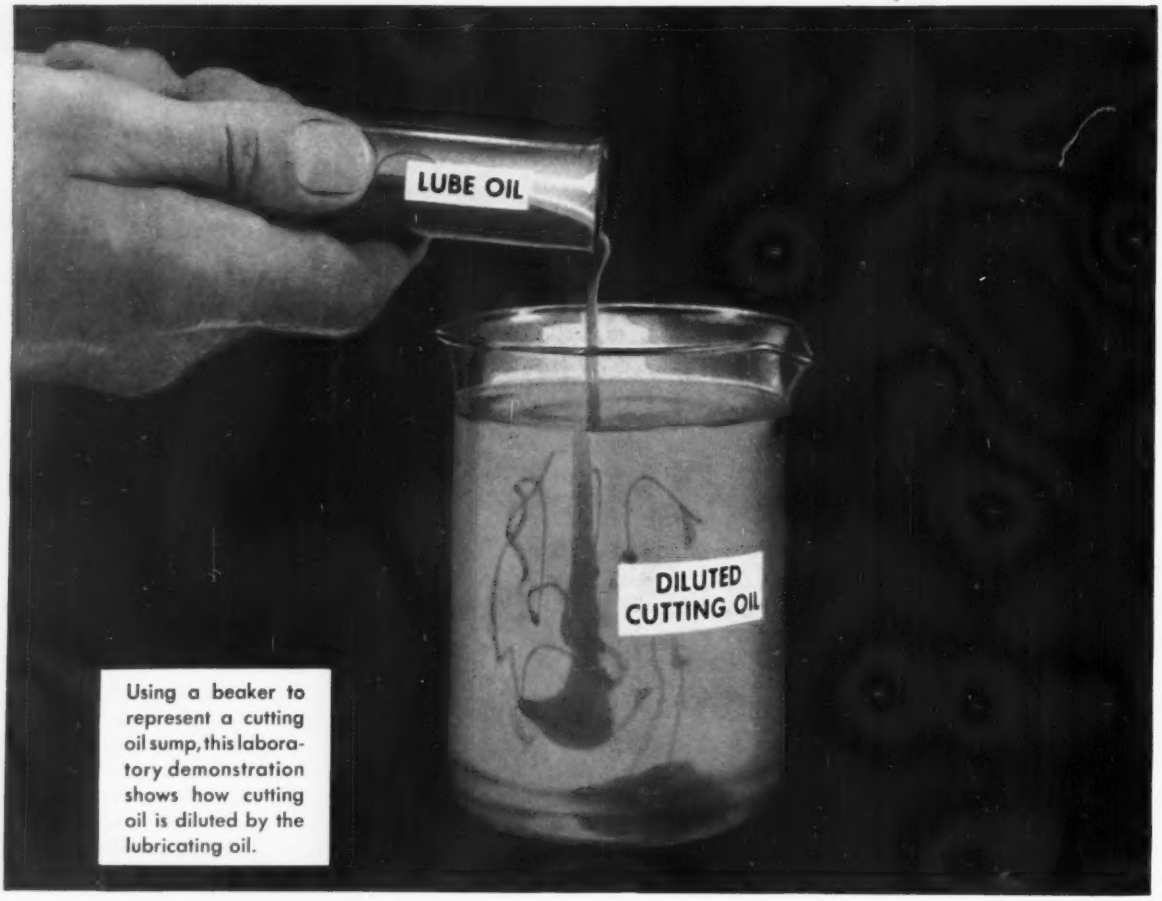
For Export: Copperweld Steel International Company, New York

The wheel covers illustrated were fabricated by Brown-Lipe-Chapin Division, General Motors Corporation, Syracuse, New York.



Using a beaker to represent a cutting oil sump, this laboratory demonstration shows how cutting oil is diluted by the lubricating oil.

Diluted cutting oil can cut output 33%

No matter how careful your lubricating techniques, you still can't stop lube oil from leaking into the cutting oil sump on 70% of automatic screw machines. As cutting oil is diluted, it loses strength—ingredients that make it efficient become less and less effective. The natural consequence is shortened tool life, more downtime and a higher percentage of rejects.

Texaco Cleartex can end this problem forever. All you have to do is use Cleartex for both cutting *and* lubrication . . . and watch your production rise. The exceptional chemical stability and load-carrying ability of the Cleartex series make them equally suitable for use as cutting oils, lubricants and hydraulic fluids. (70% of all automatic screw machines can benefit from the "Cleartex Cure!")

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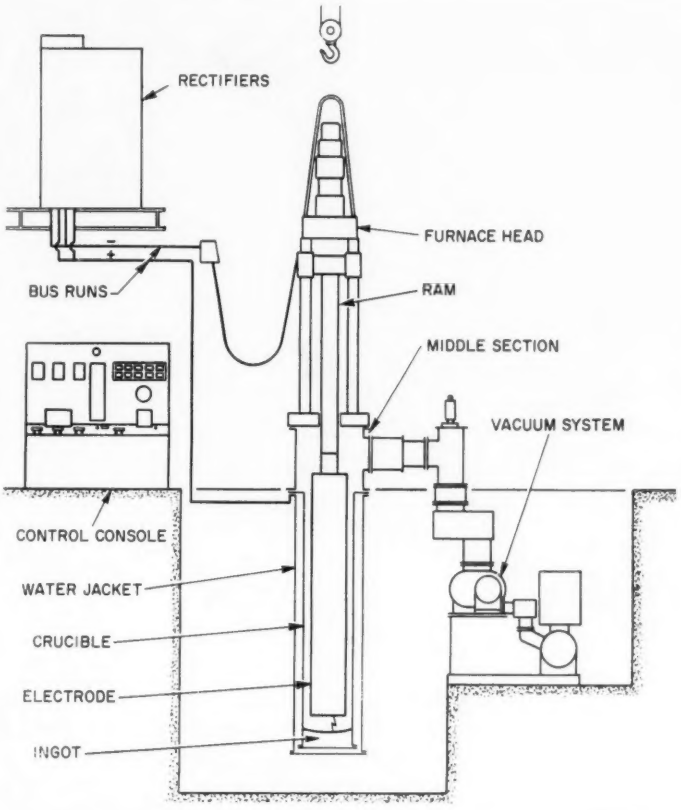
LUBRICATION IS A MAJOR FACTOR IN COST CONTROL

(PARTS, INVENTORY, PRODUCTION, DOWNTIME, MAINTENANCE)

Vacuum Arc Melting Method Upgrades Low Alloy Steels

Fabricators are getting ingots that are uniform, clean, and free of alloy segregation; mechanical properties are improved, but costs remain reasonable



All parts of Latrobe Steel Co.'s vacuum arc furnace are reached from three floor levels. Installed in early 1959, the 20 in. unit has a rated annual output of 3000 tons

MAKERS of metals for special applications are meeting a growing demand for low alloy steels that have better forming and performance characteristics. They're turning out a cleaner, stronger product with consumable electrode, vacuum arc melting furnaces or similar equipment.

In the last five years, consumable electrode melting has gained popularity in commercial steel production. Formerly, it was used to purify refractory metals.

• Consumable electrode melting offers better physical properties than those obtainable with air melting.

Center porosity and segregation of alloying elements are minimized. That is conducive to better transverse ductility and fatigue strength, making the product suitable for severe spinning operations.

Gas content is lower; gases are given off by molten metal between the electrode and bath and from the bath itself, then exhausted through the vacuum system.

Nonmetallic inclusions are substantially reduced. Large inclusions and stable compounds tend to float out during remelting and concentrate at the hot top. Smaller inclusions are dispersed through the ingot. (Stringer type inclusions, which would affect physical strength, are held to a minimum.)

Hot and cold workability are improved by vacuum arc remelting. Creep and rupture strength and impact strength are better at all temperatures.

Contamination from refractories is eliminated. Molten metal comes into contact with cold wall surfaces and solidifies instantly. And the yield of finished product from the ingot is higher for consumable electrode melting than for conventional air melted material, poured into conventional molds.

• Many steelmakers remelt ingots made by conventional methods, to give fabricators better material.

Electrodes for vacuum arc melting are as pure as conventional methods can make them. Often, they are air melted, but in extremely critical applications, vacuum melted stock is used.

Higher, more uniform quality of the remelted product makes it extremely popular in aircraft and missile applications. Some producers say it will win the same stature in tool and die applications.

Fabricators get SAE 4335 (plus V), 9310, 52100, 6150, and Ladish D6AC steels, in ingots weighing up to 15,000 lb, from Allegheny Ludlum Steel Corp., Pittsburgh. Republic Steel Corp. is producing SAE 4340, 51100, 52000, 52100, and Ladish D6A steels.

Universal-Cyclops Steel Corp., Bridgeville, Pa., makes 5 per cent chromium, hot work die steels and

(*Please turn to Page* 182)

the NEW *Roto-Finish* VIBRATRON®...

THE COMPLEX FINISHING JOBS IT DOES...
THE *REAL* MONEY IT SAVES!

VIBRATRON...
the profitable way to precision, mass production finishing

In the Vibratron, complex parts with shielded and hard-to-reach internal surfaces can be precision finished *mechanically* ending costly hand operations. *All* surfaces of the part are exposed to abrasive action *all* of the time. Time cycles are cut 300%, 500%, even more; so media and compound costs go down too!

Equally important, the Vibratron puts an end to manual handling of parts and media. A built-in, removable, double-decked vibrating separator separates parts and media, as well as fragments from the media in one simple operation. There's no need for an extra separator.

The Vibratron is simple in design. Uses standard, *tested* components which require minimum maintenance. Power requirements are low. Fixturing is easy because of the open tank design. Another advantage . . . noise level is at a low hum. The machine need not be bolted down.

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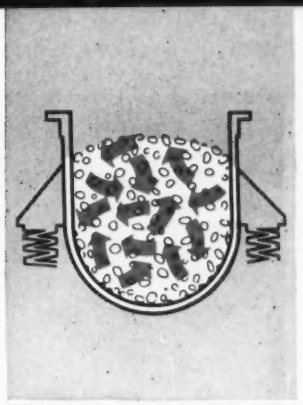
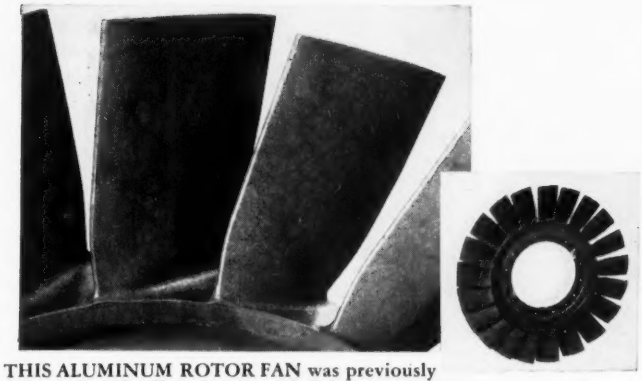
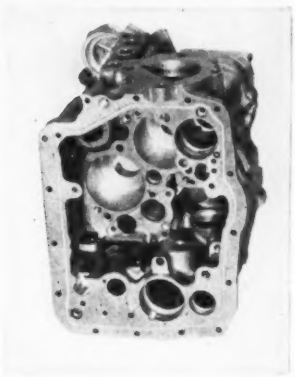
NOW THERE'S NO NEED FOR HAND FINISHING OPERATIONS ON PARTS LIKE THESE . . .



The above diagram shows how the Vibratron work zone extends throughout the abrasive mass. Every part is subject to a constant abrasive action.

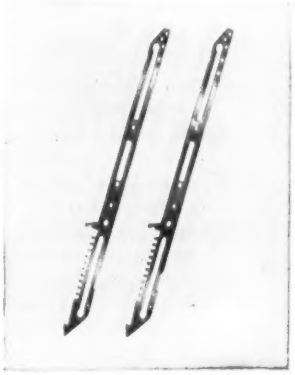


THIS ALUMINUM ROTOR FAN was previously deburred, and *still* surface irregularities were not removed. IN THE VIBRATRON they are fixtured 10 parts per machine. Time cycle: one hour. No hand work required. Surface greatly improved.



Before Vibratron processing this aluminum sand casting (shown above) was hand deburred, then tumbled into a multiple compartment machine for 30 minutes. IN THE VIBRATRON it is processed 4 parts to a machine. Time cycle: 15 minutes. No hand operations required. Finish is far more uniform.

It took two belting operations *and* 20 hours of tumbling to blend in grinding lines on these forged shears, still parts were sometimes distorted during processing. THE VIBRATRON time cycle is 6 hours. No hand work required. No part distortion.



This complex business machine part previously required hand deburring because barrel finishing bent the parts. IN THE VIBRATRON 100 parts are completely deburred in a 30 minute cycle.

With the Vibratron . . . you can clean, descale, deburr, form radii, fine-finish and color stamped, cast, forged and machine parts, finish them faster . . . better . . . and more economically.

LET US PROVE IT TO YOU

Send a few unfinished parts to us . . . and a finished part to use as a guide. *We will process them for you and guarantee the same results in your plant as we get in our finishing laboratory.*

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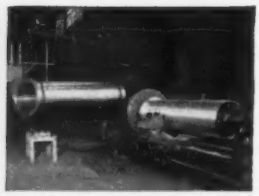

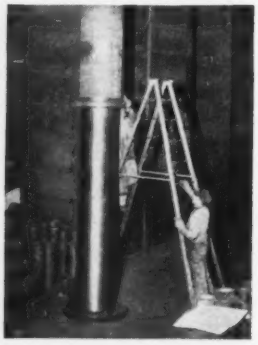

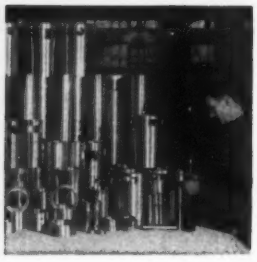

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By using Shenango centrifugal castings for essentially symmetrical parts, you will gain considerable savings because:

1. **The Shenango process automatically eliminates hidden defects in the metal . . . insures fewer rejects.**
2. **No patterns required . . . an important saving, particularly on special or small quantity runs.**
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4. **With Shenango centrifugal method control, there's less excess metal to be machined away, less metal to buy and ship!**
5. **Because of their homogeneous, pressure-dense qualities, Shenango centrifugal castings are stronger, have better wear resistance and require less frequent replacement. Maintenance cost is cut!**

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PROGRESS . . .

bearing steels, as well as SAE 4130, 4335, and 4340 grades. The company doesn't doubt the performance of vacuum melted tool and die steels, but it feels they may cost too much now and in the near future to be competitive.

Several standard high speed steels, as well as tool and die steels, have been vacuum melted at Latrobe Steel Co., Latrobe, Pa. The company has also melted SAE 4340 and 9310 and Ladish D6 grades.

Demands of fabricators determine which low alloy steels are remelted at Vanadium-Alloys Steel Co., Latrobe, Pa. Most popular: SAE 4340, 52100, 9310, M-50, and M-2 steels. The company expects to produce a 5 per cent chromium, high strength steel in volume.

• Some producers have turned to vacuum arc remelting to upgrade their own end products.

One, for instance, is Timken Roller Bearing Co., Canton, Ohio. It is producing SAE 4340 grades, AISI 52100, HS 220, and HS 260 steels by the vacuum arc process. The company will melt any other grades as they are needed for high temperature specialties, antifriction bearings, and ultra-high-strength steel parts.

Low alloy grades produced by Midvale-Heppenstall Co., Philadelphia, include AISI 4340 and 9310 grades, and Ladish D6C.

• One company produces ingots for its own use and also makes them for other fabricators.

Johnston & Funk Metallurgical Corp., Wooster, Ohio, specializes in small ingots in SAE 1020, 4340, 8620, and 9310 grades, as well as several tool and die steels.

Johnston & Funk uses much of its remelted product to make high strength, low alloy steel welding wire for aircraft and missile applications. Vacuum melting, careful drawing practices, and careful cleaning make for a mirror finished wire, free of defects that could cause faulty welds.

Firth Sterling Inc., Pittsburgh, remelts tool steel, high speed steel, and bearing steels by the vacuum arc method but uses the Hopkins process to melt SAE 9310.

In the Hopkins process, electrodes are melted under a controlled slag, rather than in a vacuum (see STEEL, Aug. 24, p. 94).

Save money!

One grease is all you need

If you use several greases to lubricate your plant equipment—stop! You'll save money with Sinclair Litholine® Industrial Grease because this one grease simplifies inventory, saves time. Recommended for all types of bearings. It has also earned an enviable reputation for high temperature bearing performance and mechanical stability. When management asks how you've cut costs, tell them you've switched to Sinclair Litholine and show them the results.

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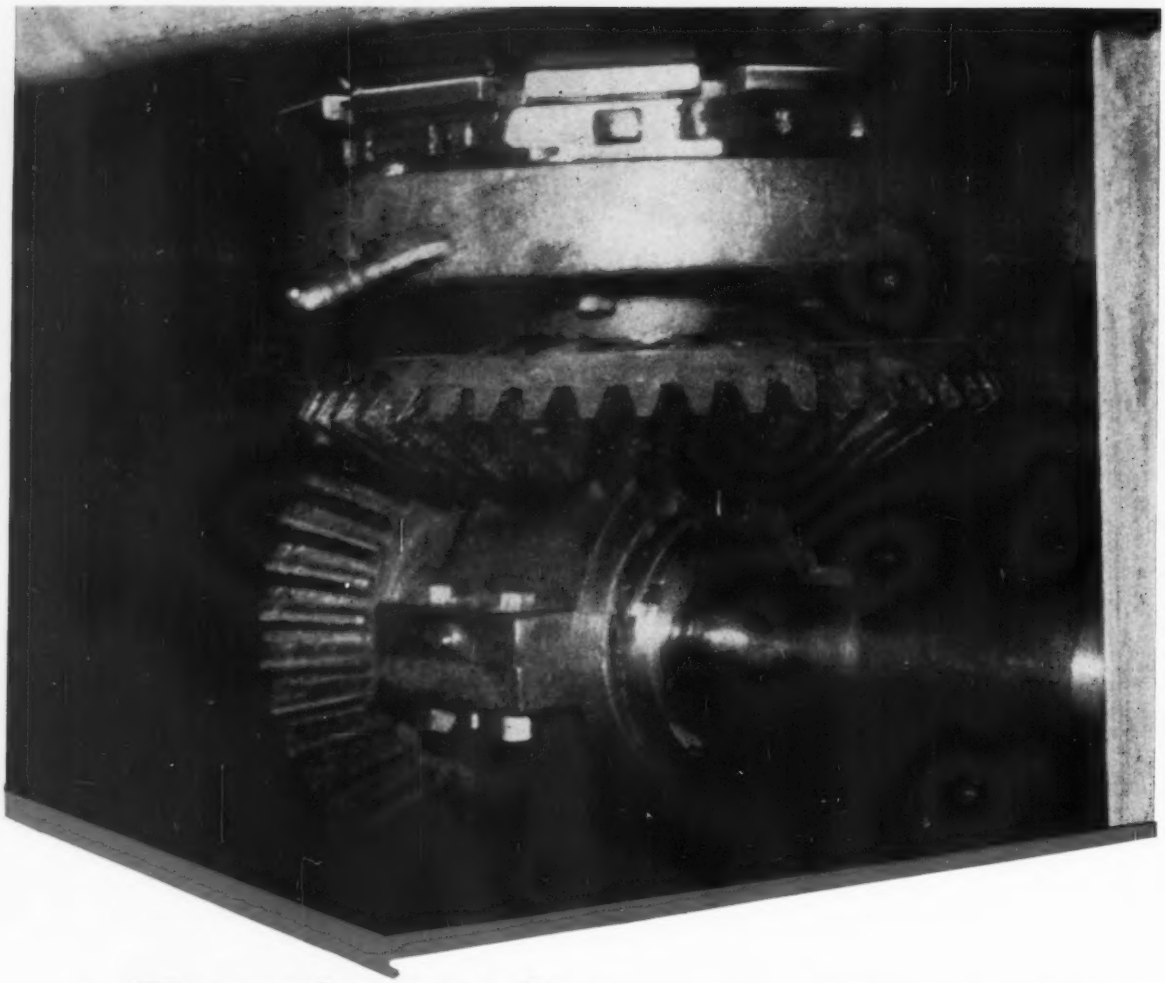

a Bearings, Inc. conversion with a 2 year record of no lost production, reduced maintenance . . . and a 30% Power Savings!

Over two years ago our engineers converted this main drive gear from a babbitt bearing to a ball bearing unit on a machine at Highland Park Manufacturing Company, Charlotte, North Carolina. Performance of this conversion, according to company engineers, has been outstanding! The housing for the bearings as well as the gear hub was produced by the customer in their own machine shop.

Prior to conversion, machine downtime was excessive because the babbitt had to be repoured every three or four months. A plus saving was in the reduction of power required to operate the machine. Highland Park Manufacturing Company officials now find power consumption is 30% less!

If your older equipment can be modernized with anti-friction bearings — our engineers can show you how. If you need bearings for any purpose, our stock carrying branches can supply you. We are *authorized* distributors of most nationally known makes of bearings. We and the makers guarantee every bearing we supply — Call the branch nearest you now!

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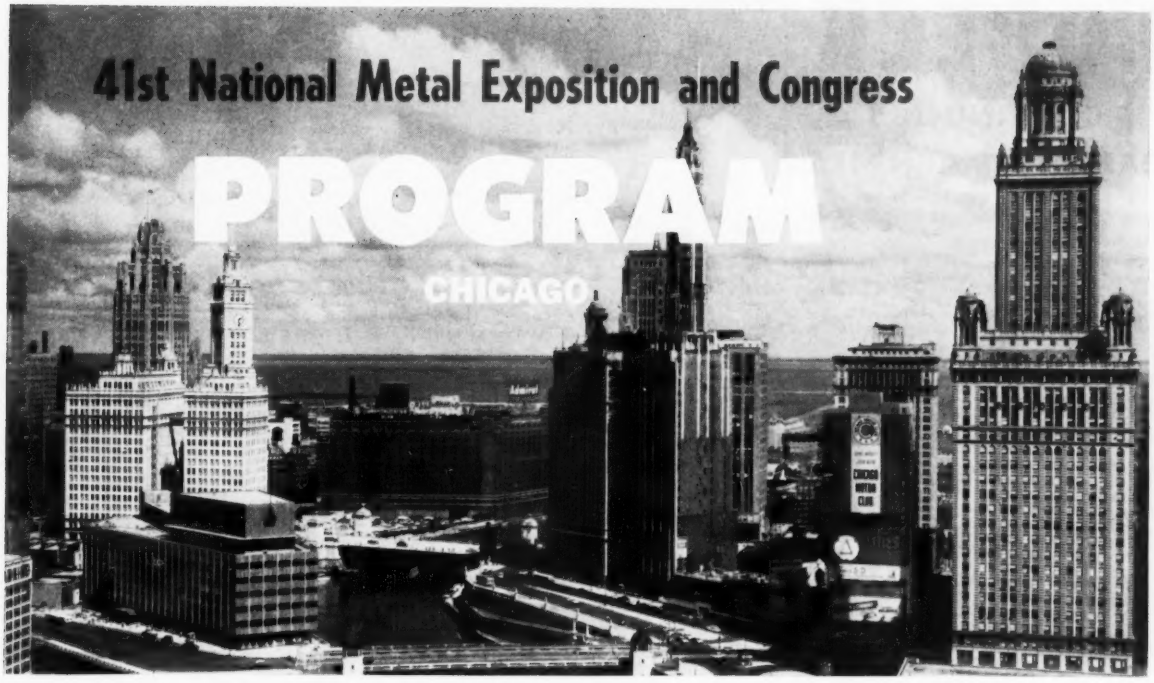


AMERICAN SOCIETY FOR METALS

Seminar

RESONANCE AND RELAXATION IN METALS

Hotel Sherman, Grand Ballroom

Chairman: W. R. Hibbard Jr., manager, Alloy Studies Research, General Electric Research Laboratory.

Programing Chairman: F. L. Vogel, Semi-Conductor & Materials Div., Radio Corp. of America.

Saturday, Oct. 31

9 a.m.

Session I—Chairman: Prof. John N. Hobstetter.

Acoustic and Magnetic Resonance—Dr. A. S. Nowick, IBM Research Center.

Cyclotron Resonance in Metals—Dr. John K. Galt, Bell Telephone Laboratories.

Nuclear Resonance in Metals at Low Fields—Dr. Alfred G. Redfield, IBM Watson Laboratory.

2 p.m.

Session II—Chairman: Dr. R. I. Jaffee.

Ferromagnetic Resonance—Dr. Donald S. Rodbell, General Electric Research Laboratory.

Relation of Metallic Bonding to Elastic Constants—Prof. C. S. Smith, Case Institute of Technology.

Session III—Chairman: Prof. Morris E. Fine.

Dislocation Relaxation at High Frequencies—Prof. P. G. Bordoni, University of Pisa, Italy.

Sunday, Nov. 1

9 a.m.

Session IV—Chairman: Prof. Morris Nicholson.

Elastic Internal Friction Effects in Crystals and Dislocations—Prof. James S. Koehler, University of Illinois.

Large Amplitude Effects and Fatigue—Dr. W. P. Mason, Bell Telephone Laboratories.

Investigation of Radiation Damage Using Acoustics—Dr. David K. Holems, Oak Ridge National Laboratories.

2 p.m.

Session V—Chairman: Dr. Raymond L. Smith.

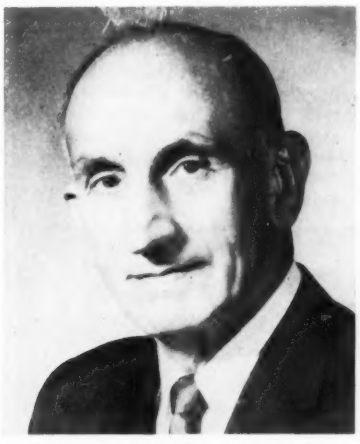
Stress Induced Atom Motion—Prof. Charles A. West, University of Illinois.

Interaction of Conduction Electrons and Acoustic Waves—Dr. Donald F. Gibbons, Bell Telephone Laboratories.

Investigations of Metallurgical Phenomena Through Elastic Constants—Prof. John Silvertsen, University of Minnesota.

(*Please turn to Page* 186)

Walter Crafts, ASM President Elect



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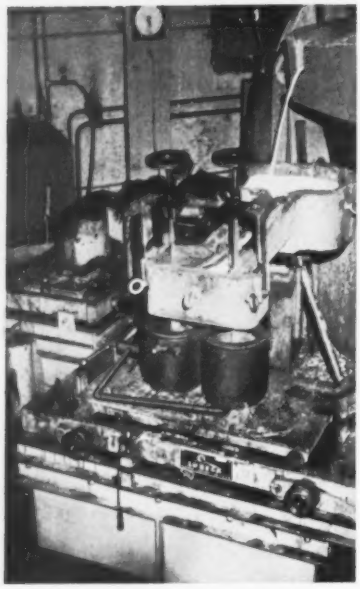

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ASM PROGRAM . . .

Technical Papers

Hotel Sherman

Monday, Nov. 2

9 a.m.

STEEL I

Chairmen: G. H. Enzian, Jones & Laughlin Steel Corp.; and W. T. Lankford, U. S. Steel Applied Research Laboratory.

Effect of Cold Work on Temper Brittleness—A. S. Keh and W. C. Porr, Research Center, U. S. Steel Corp.

Influence of Static Stress and Temperature on Internal Damping—J. W. Clark and W. C. Hagel, General Electric Co.

Correlation Between Internal Friction and Temper Brittleness in Steel—A. F. K. Kaddou and P. C. Rosenthal, University of Wisconsin.

Gas-Metal Reactions During Box Annealing of Low Carbon Steel—R. M. Hudson and G. L. Stragand, Research Laboratory, U. S. Steel Corp.

Importance of Directionality in Drawing Quality Sheet Steel—R. L. Whitely, Bethlehem Steel Co.

9 a.m.

TITANIUM

Chairmen: P. D. Frost, Battelle Memorial Institute; and Harold Margolin, New York University College of Engineering.

Anomalous Effect of Hydrogen on the Mechanical Properties of Ti-8Mn Alloy—A. H. Fleitman, Engineering Div., Crane Co.

Supersaturation as a Factor in the Hydrogen Embrittlement of Titanium Alloys—D. N. Williams, F. R. Schwartzberg, and R. I. Jaffee, Battelle Memorial Institute.

Diffusion of Oxygen in Alpha and Beta Titanium—W. P. Roe, American Smelting & Refining Research Laboratories; H. R. Palmer, Titanium Metals Corp. of America; and W. R. Opie, Research Laboratory, National Lead Co.

Kinetics of Decomposition of Alpha Prime in a Titanium-Copper Alloy—M. P. Gomez, Boeing Airplane Co., and D. H. Polonis, University of Washington.

On the Aging Behavior of the Alloy Ti-6Al-4V—J. M. Dupouy, M. B. Bever, and B. L. Averbach, Department of Metallurgy, Massachusetts Institute of Technology.

Corrosion Behavior of Titanium-Palladium Alloy—M. Stern and C. R. Bishop, Metals Research Laboratories, Union Carbide Metals Co.

2 p.m.

HIGH STRENGTH STEELS

Chairmen: G. D. Eberling, Large Steam

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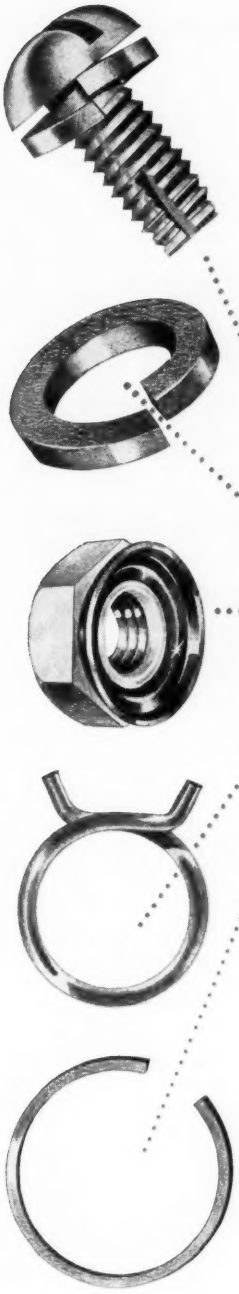

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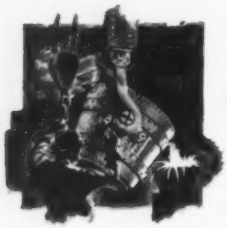

AMERICAN ORIGINALS IN IRON AND STEEL

The treasure and the fallen tree

Only after great perseverance and hardship were the tremendous iron ore reserves of this country's Lake Superior region pinpointed. Men struggled hard and long through the tangled brush, the bogs and rocks of the rough country with inaccurate maps and, often, only scraps of information.

One day in the year 1845, P. M. Everett and a Chippewa Indian chief, Marji Gesick, were investigating earlier reports concerning large iron deposits near Negaunee, Michigan.

As Everett gazed about the wild and rugged country, his attention was attracted by a nearby fallen tree, the roots of which had torn a deep bowl-shaped depression in the forest floor. Scrambling to the spot, the white man and the Indian made an important discovery.

In the rain-washed crater they saw the tell-tale red-orange markings of iron ore. Further examination proved that here, in abundance, was ore of a truly remarkable richness. *And thus was first revealed the treasure of the, now famous, Marquette Range.*

Later as the Marquette, Menominee and other ranges were developed, new methods and materials were required to make the best possible use of these new-found resources.

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Turbine Dept., General Electric Co.; and O. O. Miller, Research Laboratory, International Nickel Co.

Fatigue Properties of High Strength Steels—H. E. Frankel and J. A. Bennett, National Bureau of Standards; and W. A. Pennington, University of Maryland.

Influence of Pre-existing Sharp Cracks on Brittle Fracture of a Ni-Mo-V Forging Steel—E. T. Wessell, Research Laboratories, Westinghouse Electric Corp.

Dimensional Stability of a Precision Ball Bearing Material—E. B. Mikus, Convair Astronautics; J. M. Gerty, T. J. Hughel, and A. C. Knudsen, General Motors Technical Center.

Effect of Deformation Prior to Transformation on the Mechanical Properties of 4340 Steel—E. B. Kula and and J. M. Dhosi, Watertown Arsenal.

Strength of Martensite Formed from Cold-Worked Austenite—J. C. Shyne, V. F. Zackay, and D. J. Schmatz, Scientific Laboratory, Ford Motor Co.

Tuesday, Nov. 3

9 a.m.

STEEL II

Chairmen: Morris Cohen, Massachusetts Institute of Technology; and S. L. Gertsman, Department of Mines and Technical Surveys, Ottawa, Ont.

Effect of Austenitizing, Tempering, and Microstructure on the Properties of a Cr-Mo-V Steel—F. E. Werner, T. W. Eichelberger, and E. K. Hann, Research Laboratories, Westinghouse Electric Corp.

Effect of Cooling Rate from Ms Temperature to Room Temperature on Magnetic Properties of 3.5 per cent Chromium Magnet Steel—W. L. Hodapp, Sanderson-Halcomb Works, Crucible Steel Co. of America; and E. A. Loria, Climax Molybdenum Co. of Pennsylvania.

Effect of Small Columbium Additions to Semikilled, Medium Carbon Steels—C. A. Beiser, Union Carbide Metals Co.

Tensile Properties of Copper-Bearing, Low Carbon Steel—G. W. Bush, Pennsylvania State University; and R. W. Lindsay, Central Research Laboratory, Crucible Steel Co. of America.

Retained Austenite in Precipitation Hardening Stainless Steels—G. Krauss Jr. and B. L. Averbach, Department of Metallurgy, Massachusetts Institute of Technology.

9 a.m.

CREEP AND DEFORMATION

Chairmen: David Krashes, Worcester Polytechnic Institute; and Kurt M. Carlsen, Graham Research Laboratory, Jones & Laughlin Steel Corp.

(*Please turn to Page* 192)

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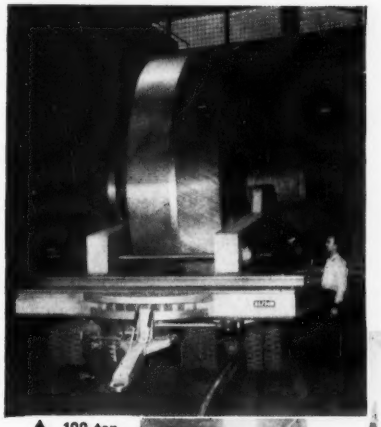

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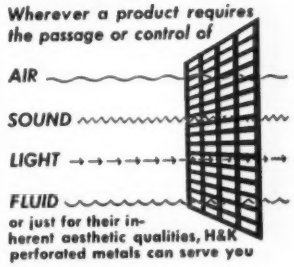

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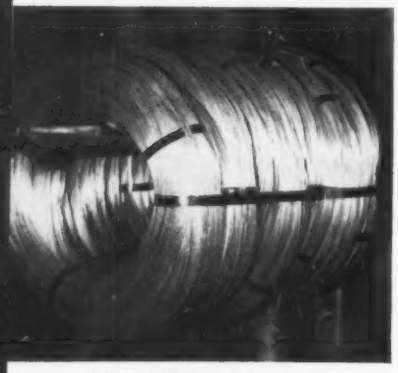

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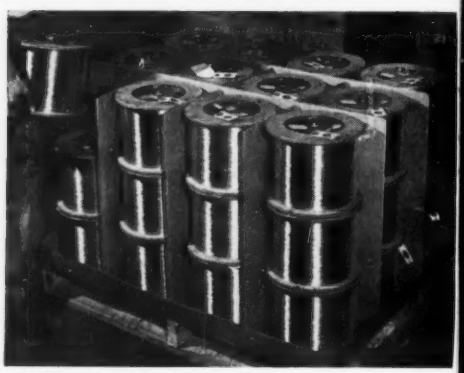

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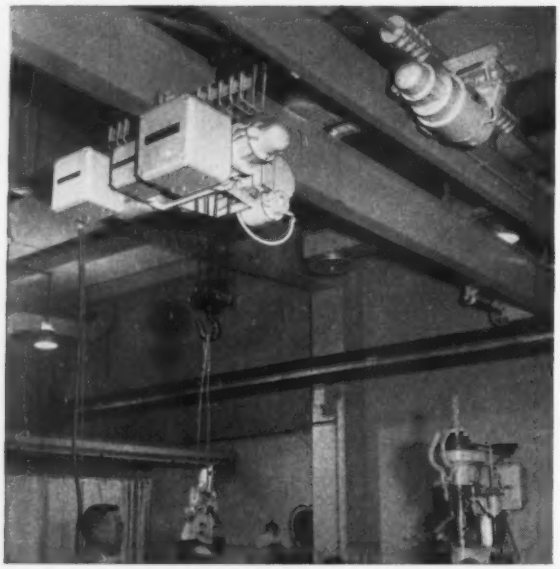

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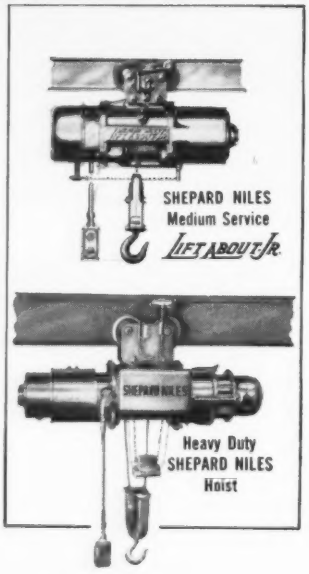

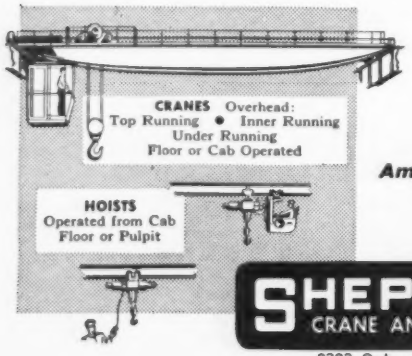

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ASM PROGRAM . . .

Effect of Stress on the Creep of Aluminum in the Dislocation Climb Range—A. Bayce, W. D. Ludemann, L. A. Shepard, and J. E. Dorn, Institute of Engineering Research, University of California.

Experimental Survey of the Deformation of the Hard-Ductile Two-Phase Alloy System WC-Co—C. Nishimatsu and J. Gurland, Engineering Division, Brown University.

Directional Grain Structure for High Temperature Strength—F. L. VerSynder and R. W. Guard, Research Laboratory, General Electric Co.

Activation Energies for Creep of an Alpha Solid Solution of Magnesium in Aluminum—N. R. Borch, L. A. Shepard, and J. E. Dorn, Institute of Engineering Research, University of California.

2 p.m.

PHYSICAL METALLURGY

Chairmen: R. A. Swalin, University of Minnesota; and W. R. Upthegrove, University of Oklahoma School of Metallurgical Engineering.

A Study of the Relationship Between State of Aging and Notch-Fatigue Performance of a High Strength Aluminum Alloy—G. W. Form, Department of Metallurgical Engineering, Case Institute of Technology.

Precipitation Process in Copper-Chromium Alloys—R. O. Williams, Cincinnati Milling Machine Co.

Effect of Trace Elements on the Tensile, Electrical Resistance, and Recrystallization Properties of High Purity Nickel—K. M. Olsen, Bell Telephone Laboratories Inc.

Thermal and Electrical Conductivities of Ductile Cast Iron and Several Gray Cast Irons—J. H. Brophy, Massachusetts Institute of Technology, and M. J. Sinnott, University of Michigan.

An Investigation of Aluminum-Copper Composites Prepared by Solid-State Bonding—J. M. Williams, Aircraft Nuclear Propulsion Dept., General Electric Co.; and M. B. Bever, Department of Metallurgy, Massachusetts Institute of Technology.

Substructure Characteristics of Fine-Grained Metals and Alloys Disclosed by X-Ray Reflection Microscopy and Diffraction Analysis—S. Weissmann, Bureau of Engineering Research, Rutgers University.

Wednesday, Nov. 4

2 p.m.

MECHANICAL WORKING

Chairman: E. M. Mahla, Pigments Dept., Experimental Station, E. I. du Pont de Nemours & Co. Inc.

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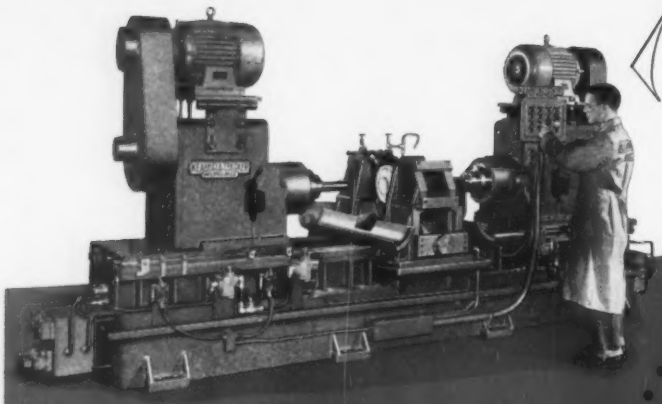

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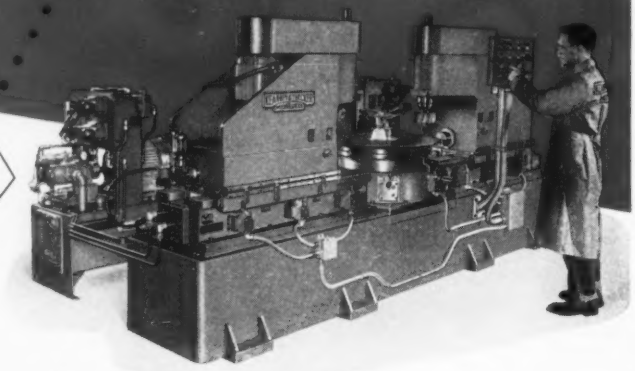

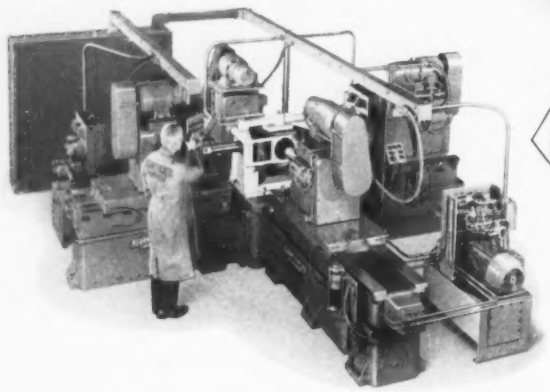

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ASM PROGRAM . . .

Effect of Rolling Variables on the Hot Rolling of Titanium and Titanium Alloys—F. R. Larson and J. Nunes, Ordnance Corps, Watertown Arsenal.

Effect of Initial Increments of Hot Working on the Mechanical Properties of Certain Ferrous Materials—H. J. Wagner, Battelle Memorial Institute; and J. W. Spretnak, Department of Metallurgical Engineering, Ohio State University.

Thermo-Mechanical Method for Relieving Residual Quenching Stresses in Aluminum Alloys—H. N. Hill, R. S. Barker, and L. A. Willey, Engineering Design Div., Alcoa Research Laboratories.

Calculation of Rolling Forces Using the Orowan Theory—J. E. Hockett, Los Alamos Scientific Laboratory.

Effect of Selenium on the Machinability and Tensile Properties of 5 per cent Chromium Steel—F. W. Boulger, Division of Ferrous Metallurgy, Battelle Memorial Institute.

Thursday, Nov. 5

9 a.m.

NUCLEAR METALS

Chairmen: W. W. Martin, Los Alamos Scientific Laboratory; and E. C. Miller, Oak Ridge National Laboratory.

High Strength Zirconium Alloys— R. K. Wagner and H. E. Kline, Atomics International.

Effect of Uranium Hydride Distribution and Recrystallization on the Tensile Properties of Uranium—H. R. Gardner and J. W. Riches, General Electric Co.

Textures in Extruded Uranium—R. B. Russell, Nuclear Metals Inc.

Transformation Kinetics and Mechanical Properties of Uranium—0.5 w/o Columbium—0.5 w/o Molybdenum Alloy—E. G. Zukas, Los Almos Scientific Laboratory.

Metallographic Study of Stringers in Inert Atmosphere Melted Zircaloy-2—J. D. Grozier, L. S. Rubenstein, and J. G. Goodwin, Core Engineering Dept., Westinghouse Electric Corp.

9 a.m.

AUSTENITIC ALLOYS

Chairmen: W. O. Harms, University of Tennessee; and S. W. Poole, Titanium Research, Republic Steel Corp.

Some Metallurgical Factors Affecting Stress Corrosion Cracking of Austenitic Stainless Steels—H. H. Uhlig, Department of Metallurgy, Massachusetts Institute of Technology; and R. A. White, Standard Oil Co. of California.

Tensile and Yield Strengths of Cr-Mn-N

(*Please turn to Page* 198)

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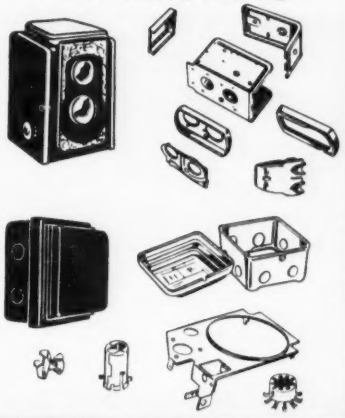
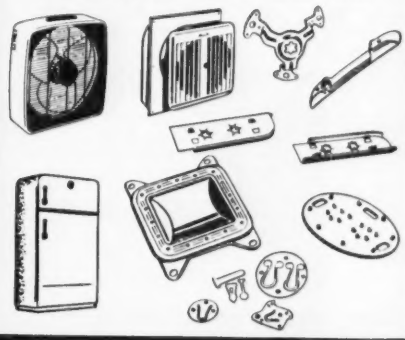


HEATING—COOLING



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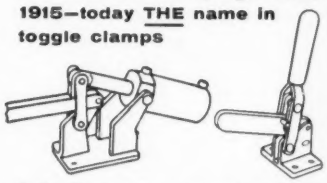

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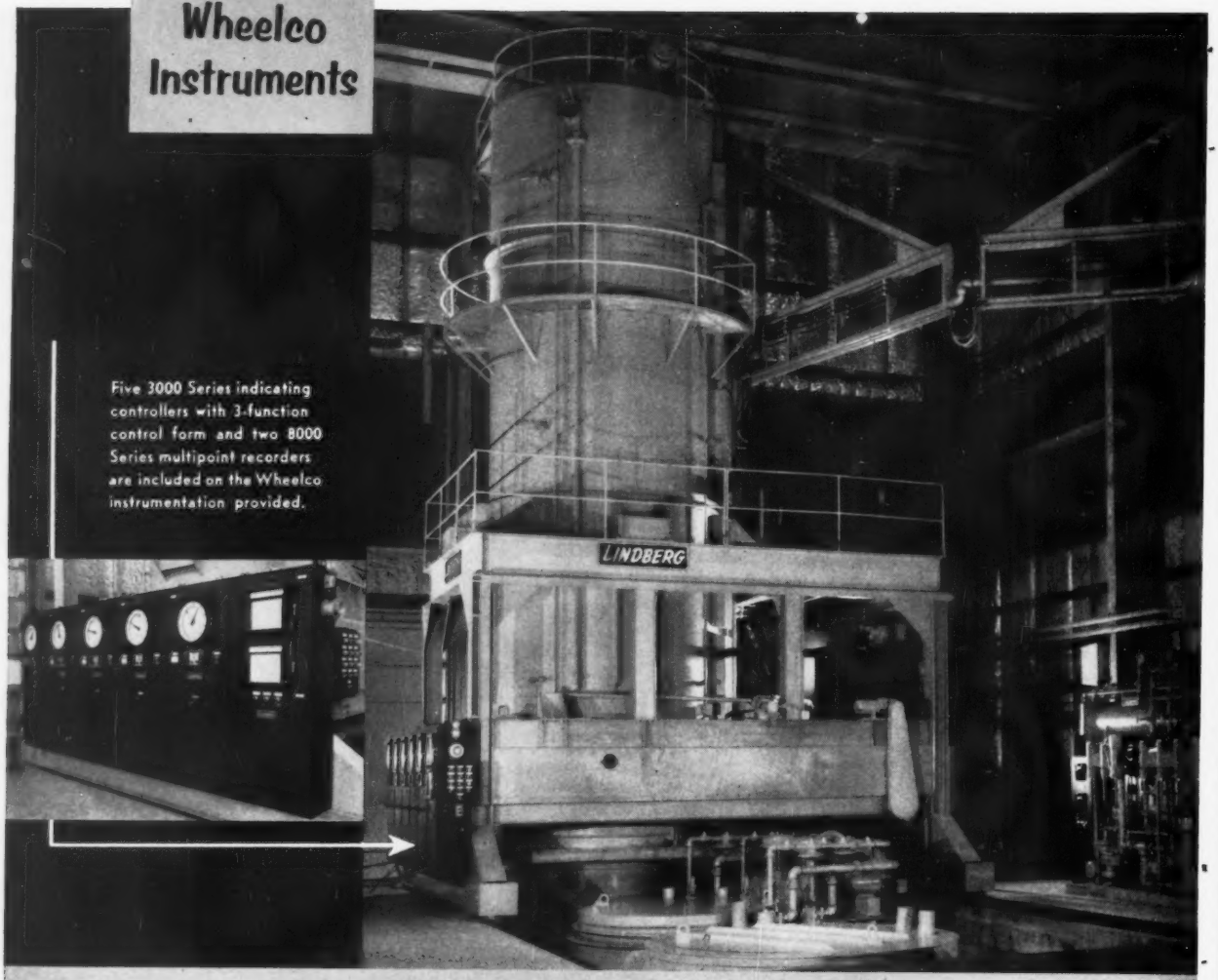

Five 3000 Series indicating controllers with 3-function control form and two 8000 Series multipoint recorders are included on the Wheelco instrumentation provided.

FIELD-PROVED WHEELCO INSTRUMENTATION

Up to 24 points are recorded at speeds of 3 to 24 inches per hour on Wheelco 8000 Series multipoint recorders. Multibank (scanner) setups permit recording 144 or more points with a single instrument.

Constant voltage source proved in more than three years of field operation and 3-function control form for proportional reset and rate action make Wheelco round and strip chart recorder-controllers outstanding.

Wheelco 400 Series millivoltmeter controllers offer a choice of six control forms. Only Wheelco offers 3-function control on a low-cost millivoltmeter controller assuring peak performance, maximum economy.

instrumentation and furnace design

Wheelco instruments provide precise 5-zone temperature control for Lindberg's giant gantry-type furnace

There's nothing commonplace about this gantry-type furnace built by Lindberg Engineering Company to handle not only the heat treatment of today's metals for aircraft and missiles but those of the future as well . The giant furnace, installed at Lindberg Steel Treating Company, is electrically heated and has five temperature control zones to insure maximum temperature uniformity over the entire range of 250°F to 2050°F.

Five Wheelco Model 3000 indicator-controllers, each equipped with an MMC magnetic modulated three-function control, provide the ultra-precise temperature control needed for work up to 24 ft long and 6 ft 8 in. diameter. These instruments working with magnetic amplifiers and saturable core reactors provide stepless control over the entire temperature range. Two 8000 Series Wheelco multipoint recorders, one for 0-1200°F range and one for 1000°F to 2200°F operation provide an accurate, permanent record of furnace temperatures.

More and more process equipment builders are proving that Wheelco instrumentation insures greater accuracy and flexibility in process and control and provides these advantages on standard, field-proved instrumentation. As shown below, Wheelco recorder-controllers and indicating controllers are available to fit a variety of needs and incorporating such features as Wheelco's thoroughly proved constant voltage source as standard equipment plus three-function control forms to meet the most exacting processing requirements. Get more data from your nearby Wheelco field engineer or write to address below.

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2000 Series round chart recorders have pen sweep speeds of 1, 4 and 20 seconds at 60 cycles. Instrument accuracy is ¼ of 1% for all scale spans in pyrometric range. Available with 3-function control form.

3000 Series circular scale indicating controller offers a large, bold, distant-reading scale. Sensing elements (same as 8000 and 2000 Series instruments) include thermocouples, radiation pyrometers and transducers.

COMPLETE CONTROL CENTERS

Wheelco-designed and built control centers are available to meet every type of process control need. Installation time and costs are reduced materially when a prewired, prefabricated control center incorporating all instruments in an attractive panel board or heavy steel cabinet is provided by Wheelco.

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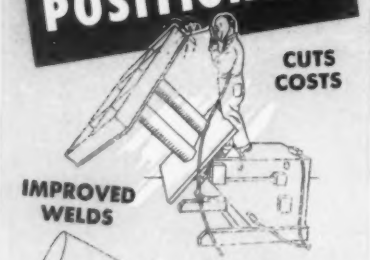

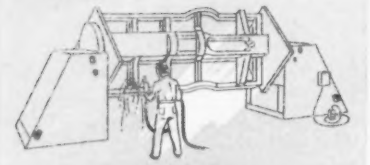

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ASM PROGRAM . . .

Steels at Low Temperatures—J. C. Shyne, F. W. Schaller, and V. F. Zackay, Scientific Laboratory, Ford Motor Co.

Effect of Interstitial Carbon Plus Nitrogen and Precipitation Reactions on the Properties of Austenitic Cr-Mn-C-N Steels—C. M. Hsiao, Peking Institute of Iron & Steel; and E. J. Dulis, Central Research Laboratory, Crucible Steel Co. of America.

Role of Boron in Cast Austenitic Alloys—R. W. Kraft Jr., United Aircraft Corp.; R. A. Flinn, Department of Chemical & Metallurgical Engineering, University of Michigan.

Structure and Properties of Austenitic Alloys Containing Aluminum and Silicon—D. J. Schmatz, Scientific Laboratory, Ford Motor Co.

Development of a Ferromagnetic Cobalt-Base High Temperature Alloy—A. Cochardt, Research Laboratories, Westinghouse Electric Corp.

2 p.m.

REFRACTORY METALS

Chairmen: H. H. Chiswip, Metallurgy Division, Argonne National Laboratory; and C. T. Sims, Knolls Atomic Power Laboratory, General Electric Co.

Properties of Refractory Alloys Containing Rhenium—C. T. Sims, Knolls Atomic Power Laboratory, General Electric; and R. I. Jaffee, Battelle Memorial Institute.

Flow, Fracture, and Twinning of Commercially Pure Vanadium—W. W. Clough, Connecticut Operations—Canel, Pratt & Whitney Aircraft; and A. S. Pavlovic, Union Carbide Metals Co.

Exploration of High Boron Alloys—A. U. Seybolt, Research Laboratory, General Electric Co.

Columbium-Oxygen System—R. P. Elliott, Armour Research Foundation of Illinois Institute of Technology.

High-Temperature Oxidation of Tungsten-Columbium Alloys—J. W. Semmel, Flight Propulsion Laboratory Dept., General Electric Co.

William Park Woodside Panel Conferences

Hotel Sherman, G. Bernard Shaw Room

Monday, Nov. 2

9 a.m.—Composite Materials.
2 p.m.—Composite Materials.

Tuesday, Nov. 3

9 a.m.—Explosive Forming.
2 p.m.—Explosive Forming.

Wednesday, Nov. 4

2 p.m.—Refractory Metals.

Thursday, Nov. 5

9 a.m.—New Fabricating Techniques and Materials.
2 p.m.—New Fabricating Techniques and Materials.

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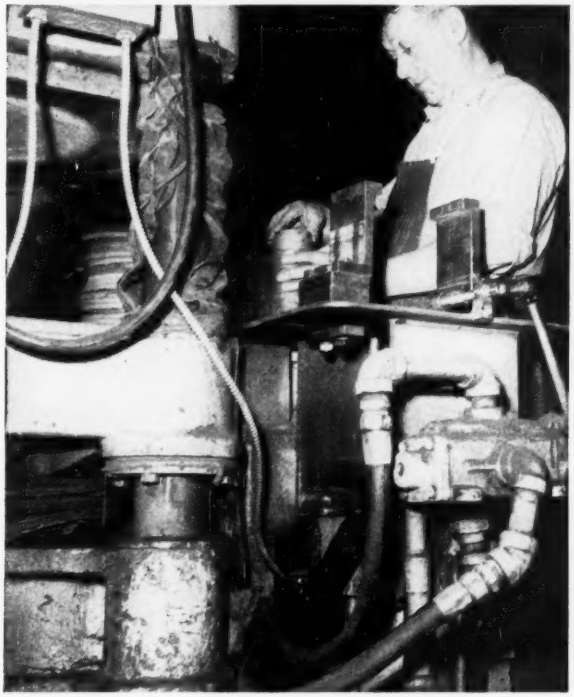
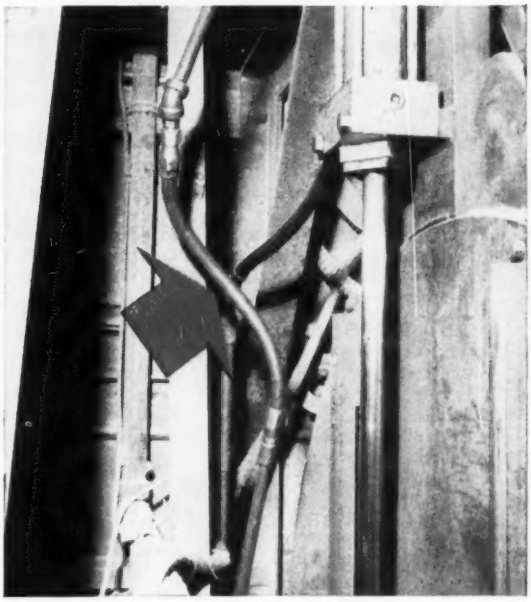


Hydraulic press forms Macklin grinding wheels. This press, as well as other Macklin plant equipment, is equipped with Aeroquip Hose and Reusable Fittings. The fittings can be used again and again, to make up new hose lines as needed.

To assure quality, Macklin Company, Jackson, Michigan, speed-tests (up to 5,000 RPM) the grinding wheels they make for industrial use.

In both manufacturing and testing, Aeroquip Hose Lines and Reusable Fittings are used in hydraulic systems. They protect the equipment from shock and vibration, and withstand abrasive dust.

Your plant equipment, too, will benefit from Aeroquip Flexible Hose Lines and Reusable Fittings. They save time, money and simplify maintenance. Call the Aeroquip Distributor listed under "Hose" in your Yellow Page Phone Book.



Aeroquip Flexible Hose Line absorbs vibration, serves hydraulic unit on Macklin's grinding wheel testing equipment, designed by the company.

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7. NO TIE-RODS TO STRETCH—gives you 360° port rotation . . . less space used . . . full strength.
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ASM PROGRAM . . .

ASM-AEC Symposium

RARE EARTHS, RELATED METALS
Hotel Sherman, Bal Tabarin Room

General Chairman: R. R. Nash, Metallurgy & Materials Branch, Division of Research, Atomic Energy Commission.

Program Chairmen: F. H. Spedding and A. H. Daane, Ames Laboratory, Atomic Energy Commission.

Monday, Nov. 2

9 a.m.—Occurrence and Extraction of Rare Earths.

2 p.m.—Applications of Rare Earth Metals and Compounds.

Tuesday, Nov. 3

9 a.m.—Preparation of Rare Earth Metals.

2 p.m.—Properties of Rare Earth Metals and Their Alloys.

AIME

Institute of Metals Division
Iron & Steel Division
Extractive Metallurgy Division

All Meetings Morrison Hotel

Monday, Nov. 2

9 a.m.

Ballroom—Symposium: Kinetics of Phase Transformations.

Constitution Room—Symposium: Preparation, Purification, and Properties of Refractory Metals.

Cotillion Room—Diffusion.

Embassy Room—Metal Processing.

2 p.m.

Ballroom—Symposium: Kinetics of Phase Transformations.

Constitution Room—Symposium: Preparation, Purification, and Properties of Refractory Metals.

Cotillion Room—Creep and Fatigue.

Embassy Room—Thermodynamic and Physical Properties.

Tuesday, Nov. 3

9 a.m.

Ballroom—Symposium: Mechanical Properties of Nonmetals.

Constitution Room—Symposium: Titanium vs. Steel.

Cotillion Room—Recent Developments in Steelmaking.

Embassy Room—Symposium: Preparation, Purification, and Properties of Refractory Metals.

2 p.m.

Ballroom—Properties of Nonmetals.

Constitution Room—Symposium: Titanium vs. Steel.

Cotillion Room—Recent Developments in Steelmaking.

Embassy Room—Symposium: Refining of Pure Metals.

(Please turn to Page 203)

Finkl die blocks and forgings made of vacuum degassed steel*

*

REDUCE DOWNTIME

Finkl vacuum degassed steels result in die blocks, hot work die steels, and forgings with greater ductility and toughness. This means that size for size, and/or hardness for hardness, the degassed steel reduces the chances of breakage and excessive wear under severe operating conditions.

*

REDUCE MACHINING TIME

Finkl vacuum degassed steels are cleaner. About 50% of the nonmetallic inclusions have been removed. Machineability is improved, with higher lusters obtainable in die block impressions, if desired. Fewer tool regrinds are required.

*

ASSURE DELIVERY

Finkl vacuum degassed steels promote high density centers in large die blocks and forgings therefore reducing the possibility of late shipment because of ultrasonic rejection.

DIE BLOCKS · FORGINGS · HOT WORK STEELS · ELECTRIC FURNACE STEELS · F

For over 80 years Finkl has been producing top quality products. Now with the introduction of vacuum degassing of our electric furnace steels we have the most complete control of quality which enables us to offer the finest in die blocks, hot work die steels and flat die forgings. Call your Finkl representative.

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ASM PROGRAM . . .

Wednesday, Nov. 4

9 a.m.

Ballroom—Symposium: Effects of Irradiation on Fuel and Fuel Elements.
Constitution Room—Surfaces and Quantitative Metallography.
Cotillion Room—Precipitation and Dispersion Hardening.
Embassy Room—Titanium.
(Note: Wednesday morning sessions scheduled 9 to 10:30 a.m. to permit attendance at ASM Campbell Memorial Lecture.)

2 p.m.

Ballroom—Symposium: Effects of Irradiation on Fuel and Fuel Elements.
Constitution Room—Plasticity and Strength of Single Phases.
Cotillion Room—Refractory Metals.
Embassy Room—Oxidation and Reduction.

Thursday, Nov. 5

9 a.m.

Ballroom—Symposium: Current Practices in the Melting and Casting of Nonferrous Alloys.
Constitution Room—Recovery, Grain Growth, and Textures I.
Cotillion Room—Theory and Observations of Imperfections.
Embassy Room—Symposium: Powder Metallurgy.

2 p.m.

Ballroom—Research Summaries: Nonferrous Melting and Casting.
Constitution Room—Recovery, Grain Growth, and Textures II.
Cotillion Room—Heat Treatment and Properties of Steel.
Embassy Room—Symposium: Powder Metallurgy.

Society for Nondestructive Testing

Hamilton Hotel

Monday, Nov. 2

9 a.m.—New Instruments and Techniques.
2 p.m.—New Instruments and Techniques.

Tuesday, Nov. 3

9 a.m.—Nondestructive Testing Correlation with Fatigue Testing.
2 p.m.—Component Reliability.

Wednesday, Nov. 4

9 a.m.—Nuclear Component Reliability.
2 p.m.—SNT Honor Session and Annual Business Meeting.

Thursday, Nov. 5

9 a.m.—Component Reliability.
2 p.m.—Inspection of Brazed Honeycomb Structures.

(*Please turn to Page* 206)

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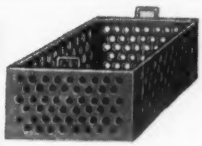
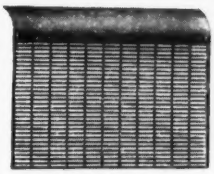
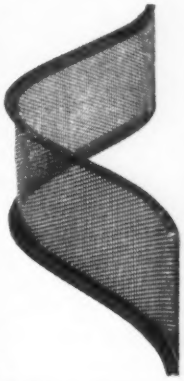


Pickling Basket



Air Inlet Screen for Oil Burner

We, of course, supply manufacturers with perforated metal sheets and plates in a wide variety of sizes and shapes, from which they produce their own products and parts, but we are also fully equipped to relieve them of a great deal of this work. We weld, spot-weld, or rivet, stiffeners and angles to the pieces and can form or flange them to special shapes as required. The items here shown are typical of hundreds we have furnished to other manufacturers during nearly a half century of successful experience.



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New Bulletin No. 51, Describes DIAMONTEX Perforated Metal Lay-in Panels for Modern Acoustical Ceilings.

SURFACE

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POWER CONVECTION

...the most significant breakthrough in heat treating technology in twenty years.

If you could step from a gentle summer breeze into an airstream of gale velocity, you'd get some idea of the vast difference between the convection often used in industrial heat treating and the new Surface Power Convection.

With Surface Power Convection, air velocities of 150 miles per hour or more are not uncommon. The work is heated under precise control in a fraction of the time usually required. Unprecedented product uniformity is achieved. Production per unit of floor space and per dollar of invested capital is raised to levels that were impossible only a few years ago.

Surface Power Convection will be demonstrated at the Metal Show in Booth 648. Be sure to see it.

fundamentals of SURFACE POWER CONVECTION

So great is the difference between ordinary convection and Surface Power Convection that it will be well to discuss this development in the light of a few fundamentals.

A heat treating furnace is essentially a device in which heat transfer by radiation, convection, and conduction takes place under control, to put parts through a time-temperature cycle.

Heat transfer by conduction serves primarily to distribute heat within the work-piece. Transfer of heat to or from the parts is by radiation and convection.

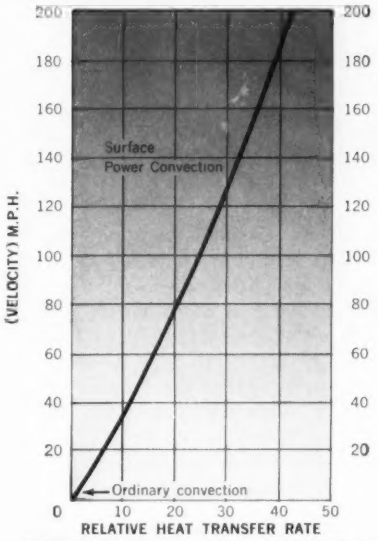
To speed production, we can increase the rate of radiant heat transfer with very high "thermal heads," in other words, with very hot "radiators."

We soon encounter many limitations, however. The geometry of the work-pieces or the load of parts in the furnace may cause parts of the work to overheat long before the main mass of the part or load is up to temperature. Differences in surface quality or color will change the heat absorbing ability of the metal and result in uneven heating and non-uniform results. Furthermore, when "radiator" temperature is substantially above desired maximum work-piece temperature, control of heat transfer rate is critical and difficult.

Finally, thermal heads are limited by the very practical problem of the maximum operating temperatures of the materials feasible for radiators and other structural material in the furnaces—usually about 2000° F.

On the other hand, with *convection*, we can increase the rate of heat transfer without such critical control problems or dangers of overheating, by raising the velocity of air movement and maintaining only a relatively small thermal head.

The amount of heat transferred to the work is now determined mainly by the velocity of air movement, and hence we can raise the upper limits of heating rates very significantly. The desirability of convection heat transfer at extreme velocity has long been known; its advantages in terms of improved uniformity, increased speed, and reduced floor space are clear.



Surface Power Convection utilizes the highest air velocity to achieve a maximum heat transfer coefficient consistent with application requirements.

Why, then was Power Convection not developed long ago? Chiefly because the engineering design problems—involving mechanics, aerodynamics, thermodynamics, metallurgy, to name only a few—were so formidable. For instance, fan blades had to be designed for maximum aerodynamic performance, to operate continuously under high dynamic stress at elevated temperatures. This brought a host of problems unheard of in conventional furnace design and manufacture. Soon it became apparent that air movement patterns were determined not just by fan design but by the geometry of the parts, density of loading, configuration of the furnace interior, baffles and work handling devices.

It was not enough just to build fans that would function in extreme environments: it was a matter of accumulating a wealth of new data on high temperature convection in a range of velocities never before explored, then solving a large array of interrelated problems so that reliable predictions of furnace performance could be made.

In effect, the furnaces would behave like wind tunnels, handling air at temperatures close to the physical limits of our materials. This is what Surface has developed over a period of years.

We can now present and define a new measure of furnace performance: *convection power*—a rating of the capability of a furnace to transfer heat to its work load primarily by convection, with great speed, uniformity, and efficiency. And convection power can now be evaluated in economic terms.

While some problems remain to be fully worked out, we have charted such a large area of this new technology that we can say with confidence:

Surface Power Convection raises the capabilities of heat treat production significantly above previously accepted limits of performance. Cooling as well as heating is remarkably speeded up, and the uniformity of heat treatment in controlled atmospheres is improved.

Surface Power Convection now permits designing furnaces with heat transfer rates limited not by our abilities to produce and distribute heat, but by the physical abilities of work-pieces to absorb it.

Write for Bulletin SC-182 for further data on this new development.

SURFACE COMBUSTION CORPORATION
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Surface

HOT SPOT in your plant!

Guard spray booths, dip tanks, record vaults against the danger of fire! Guard them 24 hours a day with a Kidde fully-automatic carbon dioxide fire extinguishing system. Finest fire protection on the market today, Kidde systems give you these outstanding features that come from more than thirty-five years' experience!

All operating parts completely enclosed to guard against fouling or accidental operation.

No clumsy triggering methods or falling weights.

Self-contained; no outside power needed.

Visual indicators to show if system has been operated.

Easy testing of all operating parts.

No parts to replace after operation or test.

Fast-acting clean carbon dioxide does the job that no other extinguishing agent can do: snuffs fire out in seconds, then vanishes into thin air. Won't harm valuable machinery, leaves no mess to clean up. Write for Kidde's pressure operated carbon dioxide fire extinguishing systems booklet today.

Kidde (K Kidde)

Industrial and Marine Division
Walter Kidde & Company, Inc.
1060 Main St., Belleville 9, N. J.

Walter Kidde & Company of Canada Ltd., Montreal—Toronto—Vancouver

ASM PROGRAM . . .

Friday, Nov. 6

EDUCATIONAL CLINIC

9 a.m.—Radiography, Dark Room Techniques, Fluoroscopy, and Magnetic Particle Inspection.

2 p.m.—Penetrant Inspection, Eddy Current Test Methods, Two Phases of Ultrasonics (Theory and Application), and Writing in Modern Technology.

Metal Treating Institute

Hotel Sherman, Assembly Room

Thursday, Nov. 5

2 p.m.

Heat Treatment of Gears—Panel discussing all types of heat treating for gears.

How to Obtain Specified Requirements Through Heat Treating—L. J. Haga, State Heat Treat Inc.

Carbon Control During Heat Treatment—Frank Hobbs, Ipsenlab of Canada Ltd.

Ultrasonic Manufacturers Association

Hotel Sherman, Grand Ballroom

Thursday, Nov. 5

9 a.m.

Three papers specializing in the noninspection techniques, stressing ultrasonics as a medium for joining, cleaning, hardening, welding, soldering, brazing, drilling, machining, and grinding.

Special Libraries Assn.

FALL MEETING

Chairman: Mrs. Moira Jones, Chairman, Metals Division.

Arrangements Chairman Pro Tem: Sam Iden.

Thursday, Nov. 5

9 a.m.

Institute for Study of Metals, University of Chicago. Papers by staff of institute.

Afternoon

Lunch, movies, tour of Argonne National Laboratories.

Evening

Joint dinner meeting with Illinois Chapter, SLA.

Friday, Nov. 6

9 a.m.

LaSalle Hotel—Papers on Steel Strapping and Methods of Applying It to Packaging by Acme Steel Co. officials.

Afternoon

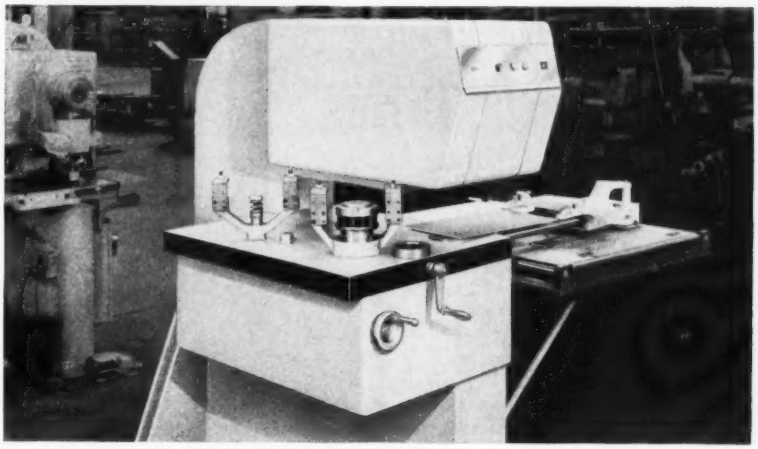
Tour of Acme Steel Co., Riverdale, Ill., plant observing continuous cupola-oxygen converter process of steelmaking.

Punch Press Has 30 in. Throat Depth Capacity

IN STRAIGHT line punching, the Super 30 Fabricator (with the Strippit multiple stop gaging system) will handle a 30 in. workpiece of any length.

Maximum work size when production punching with the Strippit Duplicator is 25 x 30 in. Punching capacity ranges from a 3½ in. hole in 16 gage mild steel to a ½ in. hole in ¼ in. mild steel (±0.005).

It will handle 90 degree corner notching up to 5 x 5 in. in 16 gage mild steel as well as rectangular, radius, vee, and special notches. Straight line nibbling and contour shearing can be done at 165 strokes per minute, with a capacity of ⅛ in. in mild steel. Changeover from single stroke punching to nibbling can be done quickly. The quick-change punch and die system enables the operator to change sizes in less than 20 seconds.



Among other features is the electric head that controls ram operation. It has fewer parts and eliminates the need for pressurized air. An adjustable table permits the use of pedestal dies to enable the operator to punch holes in angles, shapes, and formed parts.

You can see this press at the Metal Show, or *write* Wales-Strippit Inc., a unit of Houdaille Industries Inc., 210 S. Buell Rd., Akron, N. Y.

Power Saws Cut Faster, Are More Accurate

GREATER accuracy, operator convenience, and higher production rates are claimed for the Model C-67 and C-68 power saws. The C-68 has a 12 x 12 in. capacity with fully automatic stock indexing. The C-67 is a manually fed version with a capacity of 12 x 16 in.

Controls and dials are grouped for best sequence of operation from either side of the units. Spring loaded saw guides compensate for band gage differences and band wear. The machine bed has replaceable wear plates. Coolant is carried to both sides of the band for longer life and better finish.

Unnecessary cutting head travel is eliminated by a work height selector. The cutting head can't be moved when the machine is turned

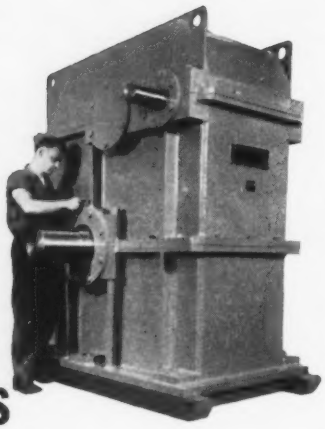
Remember—

H & S

saves you time
and money on

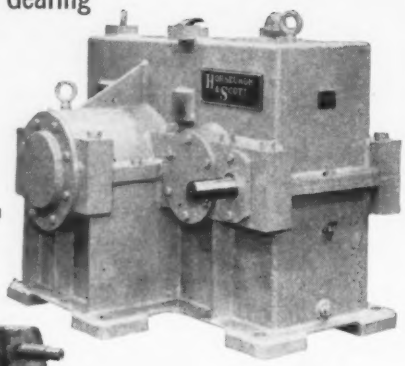
Large Special Drives

Helical · Herringbone · Worm Gearing



H & S engineers are thoroughly experienced in the design of special drives—can solve unusual drive and transmission problems at the lowest possible cost . . . in the shortest time. Can we help you? Write or call today.

For data helpful in selecting all types of speed reducers and gearing, our Catalogs 55 and 57 are available on request.



THE HORSBURGH & SCOTT CO.

GEARS AND SPEED REDUCERS

5112 Hamilton Avenue • Cleveland 14, Ohio

NEW PRODUCTS and equipment

off. If the saw band is not at proper tension, a safety switch prevents operation.

The indexing mechanism of the C-68 can be quickly set up and is automatic. A hydraulic indexing vise feeds stock up to 12 in. in diameter (or 12 in. square) in length increments up to 24 in. Capacity is 4000 lb. Length of cut can be easily set to within 1/16 in. Length accuracy is ± 1/64 in., but it can be held to a few thousandths in production, says the company.

You can see these saws at the Metal Show, or *write* DoAll Co., 256 N. Laurel Ave., Des Plaines, Ill.

Electric Hydraulic Press Has 60 Ton Capacity

BENDING, straightening, and pressing can be done on this 60 ton electric hydraulic press. Safety features include a factory set bypass valve which prevents overloading.

A ram travel limit control mechanically moves the control valve lever to neutral position when the ram has reached maximum travel. In addition, a Helicoid gage has been inserted into the pressure line to record all pressure readings during operation (it shows when full press capacity is being reached).

A three position valve that will automatically return to neutral from either the ram advance or retract position controls the press. The power package is rated at 25 per cent duty cycle at full load and 50

Call on Marathon for steel of the highest quality . . . high speed, tool, alloy, stainless and heat resistant. Available in bars, sheets, wire, castings and forgings, etc., conforming to S.A.E. and A.I.S.I. specifications, plus many other special steels to meet individual requirements. Additional information and details gladly supplied. Contact us for immediate attention to inquiries and special problems.

MARATHON

SPECIALTY STEELS, INCORPORATED

A Division of Deutsche Edelstahlwerke A. G., Krefeld, West Germany DEW 375 Park Avenue, New York 22, N. Y.

per cent duty cycle at three-quarter load.

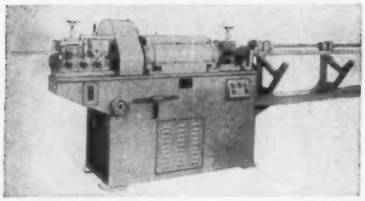
The press has a 7⅛ in. ram stroke at a ram speed of 25 in. per minute at zero load, and 17 in. per minute at capacity. The drive motor is 5 hp.

You can see the unit at the Metal Show, or *write* Acco Equipment Div., American Chain & Cable Co. Inc., 1110 E. Princess St., York, Pa.

Automatic Machine Cuts, Straightens Wire

YOU can cut and straighten wire 5/32 to ⅜ in. in diameter with the Model 2ABV.

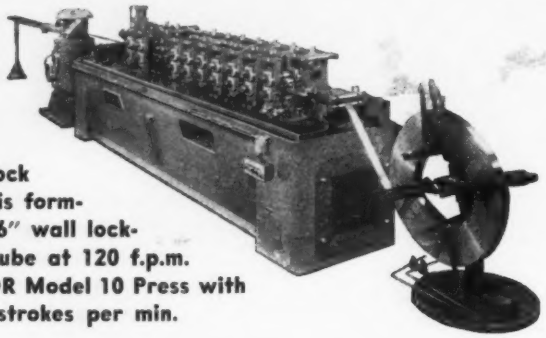
The unit is a straightening arbor high speed type, with five elongated split dies. Ball bearings minimize vibration. You have a choice of feed ranges (50 to 200 fpm) with the variable speed drive. An electric brake is on the clutchshaft.



The feed roll housing and gear driven five roll preliminary straightener are totally enclosed with shafts mounted on Timken bearings.

You can see this machine at the Metal Show, or *write* Mettler Machine Tool Inc., P. O. Box 883, New Haven 4, Conn.

AMERICAN ROLLER DIE CORP.
ARDCOR HIGH PRODUCTION ROLL FORMING MACHINE FOR ALUMINUM SHAPES



This Model SF Lock Seam Tube Mill is forming ⅝" O.D., .016" wall lock-seam aluminum tube at 120 f.p.m. Cutoff is ARDCOR Model 10 Press with 1½" stroke, 60 strokes per min.

The new small Model SF ARDCOR Machine features: High production speeds; spindles 1.5"; new style rugged base with tool compartment and slanted front recessed for better operator stance; special narrow side roll stands with close 10" horizontal centers; fixed spur gears; quiet running all V-belt drive; low voltage protection. Basic machine readily converted to a Cold Roll Forming Machine.

ARDCOR Roll Forming Machines and Lock Seam Tube Mills are available in seven standard sizes, other sizes to customer specifications.

If your products can be cold roll formed, ARDCOR engineers can supply advancements in design and machine construction to produce them better . . . at greater speeds and profit.

Consult our Engineering Facilities, without obligation . . .

American ROLLER DIE CORP.

29520 Clayton Avenue Wickliffe, Ohio

ARDCOR Engineered NEEDS BETTER COLD ROLL FORMING

DESIGNERS, ENGINEERS AND BUILDERS: Single Roll Forming Machines or Completely Automated Production Lines for Cold Forming, Ferrous and Non-Ferrous Electric Weld and Lock-Seam Tube Mills • Forming Rolls, Tubing and Pipe Rolls • Straightening, Pinch and Leveller Rolls • Cut-Off Machines • Slitters

Carbon Brick for Furnaces Has Low Permeability

CARBON brick for blast furnace linings and aluminum cell applications is said to be considerably less permeable than conventionally produced anthracite carbon brick.

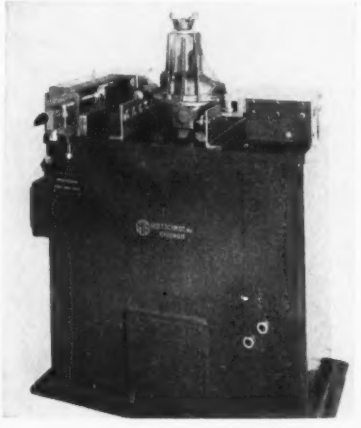
The Grade NMA brick has a thermal conductivity about seven times greater than ceramic brick.

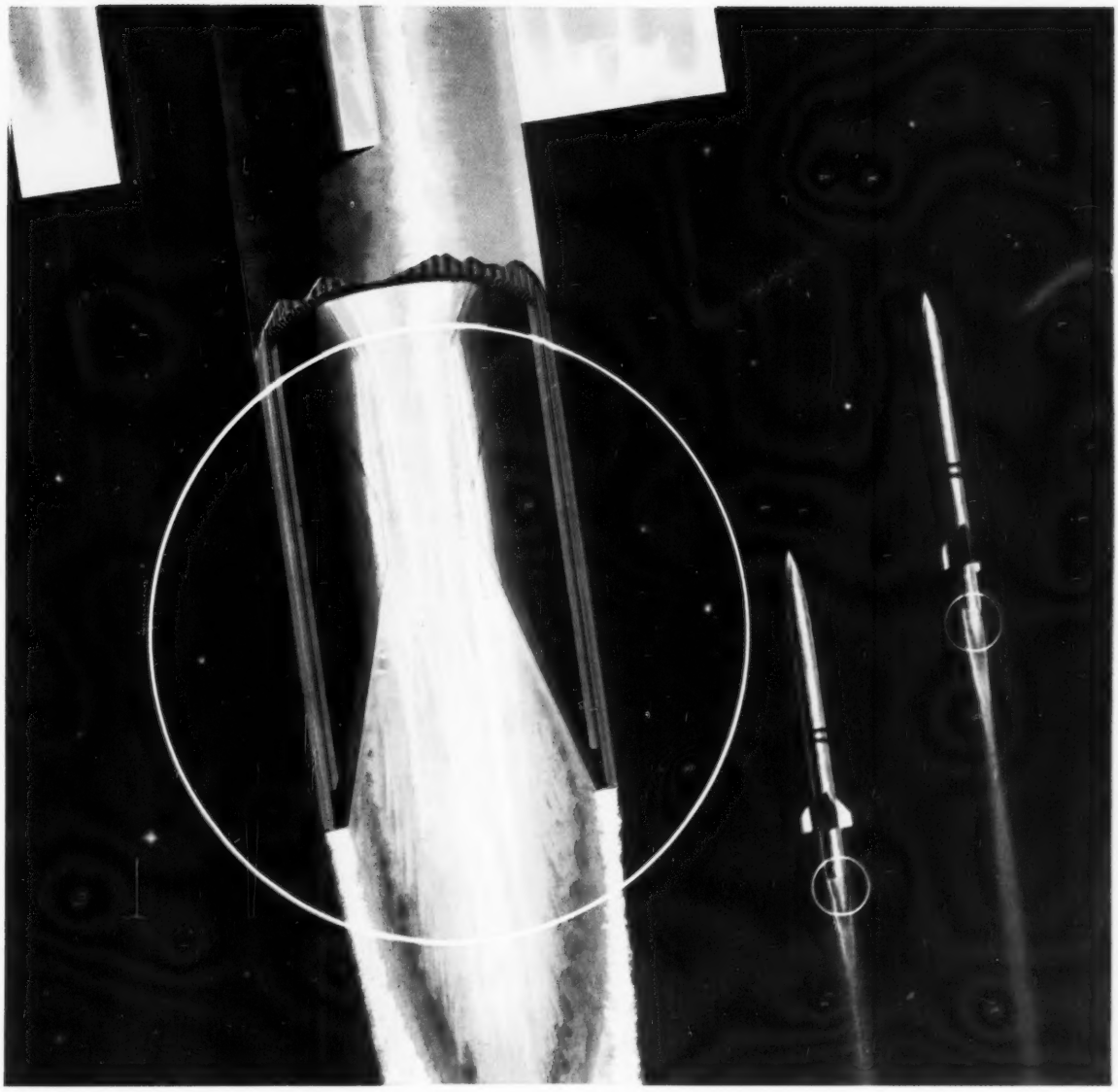
You can see the brick at the Metal Show, or *write* National Carbon Co., a division of Union Carbide Corp., 30 E. 42nd St., New York 17, N. Y.

Hydraulic Marking Machine Handles Round Parts

A WIDE RANGE of round parts can be adapted to production marking. The Model 465 marking machine shown can do the job. It is conveyor fed and discharged. It's set up to mark gear carriers.

Operation: A hydraulic shuttle





REFRACTORY MATERIAL FORGINGS FOR 5000° F TEMPERATURES

Cameron forgings have solved many a design problem, but this is one of which we are particularly proud. Nozzle throats in solid propellant missiles must control the fantastic temperatures which make high performance possible. All the push passes through this part and temperatures range over 5000° F almost instantly, but the throat insert must maintain its shape for peak burnout conditions. Just to complicate matters, the exotic alloys specified for these important parts are extremely brittle and expensive. In forming and machining the costly metal every ounce is important — with conventional processes fragility makes matters worse.

When Cameron's unique forging methods were applied to this unfortunate situation, some interesting things happened. Our years of experience in forging high stress, high temperature components helped change the picture completely.

Less material was required because our specially designed presses could forge to a near-final shape. Moreover, the ductility of these tricky alloys was increased, making them easier to handle and machine. As a result, we are now turning out quite a variety of our advanced forgings for nozzle throats to help give missiles the proper push.

Cameron forgings have opened many possibilities in advanced design today. Extreme service components for airframes, jet engines, guided missiles, nuclear power plants, and a wide range of other end uses are being forged by the Cameron split-die and down-acting presses.

If your design problem involves high stresses, high temperatures, or large, intricately shaped ferrous parts, maybe we can help. Just call, write, or come by . . .

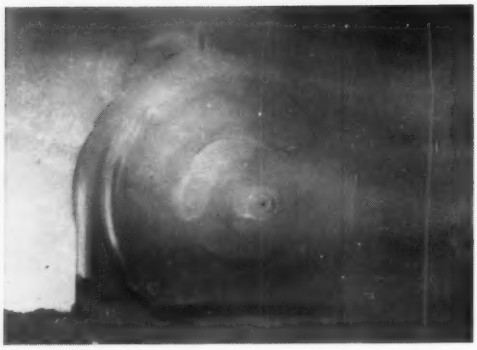
Cameron

IRON WORKS, Inc.

SPECIAL PRODUCTS DIVISION
P. O. Box 1212, Houston 1, Texas

REFRACTORY MATERIALS: Molybdenum • Tungsten • Tantalum • Moly Tungsten • Tantalum Tungsten and others.

PICKLED in a 4% brine solution!



CHOKED
in a tornado of abrasive dust!

FROZEN
for weeks at 75° C below zero!

BURIED ALIVE
in thick, sluggish mud!

nothing . . . but nothing stops Super-Seal open-type motors

Thanks to exclusive Poxeal and Silco-Flex insulations, Super-Seal motors have shown endurances that even enclosed motors couldn't match. Results and reasons available from your A-C representative or distributor. Or write General Products Division, Milwaukee 1, Wisconsin

ALLIS-CHALMERS A-1151

Poxeal, Silco-Flex and Super-Seal are Allis-Chalmers trademarks.

feed positions the parts into retractable cradle nests. A hydraulically operated die slide (with a lettering tool in marking position) rolls the legend into the periphery of the metal parts. Each successive number is indexed automatically on the return stroke of the die slide.

Combinations of characters can be furnished for different numbering or marking requirements. You can get them equipped to use type or die holders or numbering heads. Floor space needs are 35 x 18 in.

You can see this unit at the Metals Show, or *write* Geo. T. Schmidt Inc., 4100 Ravenswood Ave., Chicago 13, Ill.

Profile Milling Machine Cuts Radiuses, Shapes Fast

SIMPLE radiuses and irregular shapes can be cut in seconds with no setup or layout on the McKay Radii. You can get either standard semiautomatic or fully automatic models.

No experience or training is needed for operation. On the semiautomatic model, the material is put in a vise and the operator moves a handle through a 180 degree arc. Pushbutton control actuates the tool on the automatic version.

The semiautomatic type cuts simple radiuses. The automatic machine will produce any profile within a 180 degree arc. It can mill irregular shapes as well as true radiuses in a fraction of the time required by other methods, says the company. Floor space requirements are less than 10 sq ft for the units. Only standard shop electrical and air facilities are required.

You can see the models at the Metal Show, or *write* McKay Machine Co., 546 Lincoln Ave., Youngstown 1, Ohio.

High Speed Gun Drives Wire Thread Inserts

UP to 1200 wire thread inserts per hour can be installed with the Heli-Coil miniature tool. The hopper feed and lightweight gun permit automatic assembly line operations in any type or size of material.

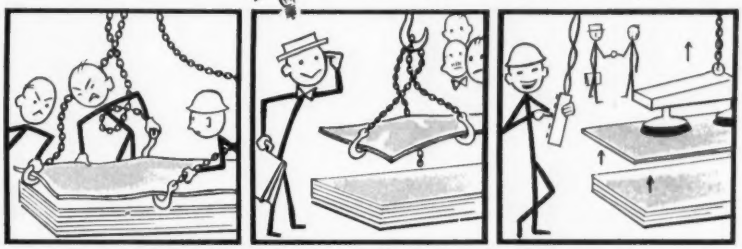
The 18 ounce gun can be remotely operated up to 8 ft away from the hopper feed mechanism. Operation: A foot operated switch ejects an insert from the hopper through a nylon tube to the inserting tool tip. When the insert is fully installed to a preset depth, the driving mandrel automatically stops.

At that point, the tool is ready for the next insert.

You can see this tool at the Metal

(*Please turn to Page* 216)

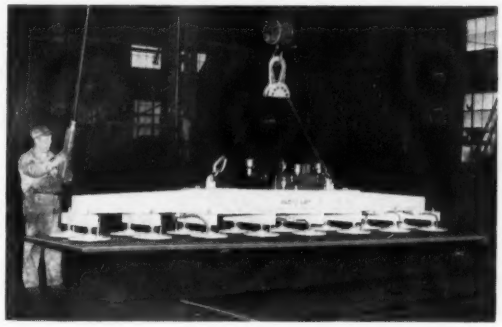
VAC-U-LIFT VAN Solves another Material Handling Problem!



1 A group of the hardworking boys were lifting steel plate—a real bottleneck and backbreaking job that hasn't changed for years . . . but then . . .

2 Along came VAC-U-LIFT VAN — Of course this problem was a natural since he had helped a lot of other industries with this same problem.

3 Back from the plant with a speedy quote . . . quick delivery of a unit, VAC-U-LIFT VAN has made a new group of friends. Now one man controls moving steel plate and again proves VAC-U-LIFT has the Solution.



VACUUM STEEL PLATE HANDLER

Prior to installation of the vacuum plate handler, the same operation required 3 men for operation of the crane and attaching chains. The Vac-U-Lift unit shown in photograph requires only one man for complete operation which means faster, safer and more economical steel plate handling. This unit lifts and conveys over 4½ tons of steel plate and is adaptable for use with overhead traveling crane, boom crane and stiff-leg crane.

Your problem may not be illustrated here, but if you do have a handling problem, Vac-U-Lift's experience and engineering know-how, through the expert use of vacuum, can help you. Vac-U-Lift systems are currently being used to control, position, and maneuver a multitude of materials weighing from 20 tons down to a few ounces.

All Vac-U-Lift units carry a full 3 month unconditional warranty.

VAC-U-LIFT

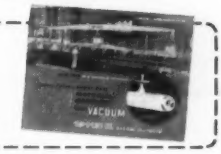
HAS THE SOLUTION!

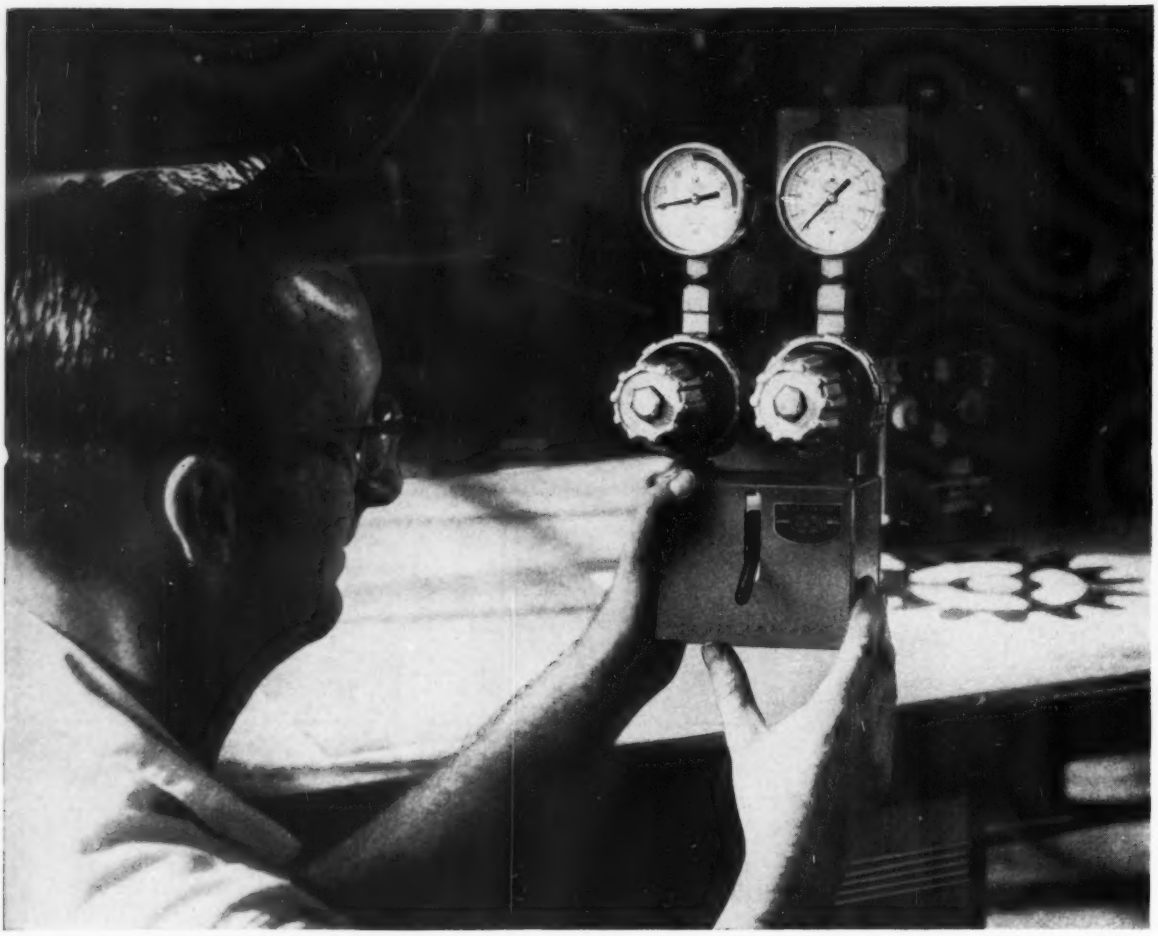
Send Today For FREE Illustrated Brochure

This brochure shows some of the many VAC-U-LIFT systems now in use. It explains how VAC-U-LIFT works and how you can take advantage of VAC-U-LIFT'S 3-step analyzation service without cost or obligation, write

DEPT. VL-84, VAC-U-LIFT CO., Salem, Illinois

Division of the Siegler Corporation





AIRCO'S NEW HI-LO CONTROL FOR MACHINE TORCHES

gives you substantial gas savings

IT SAVES GAS BECAUSE YOU CAN GET

- *proper preheat flow for starting a cut*
- *minimum flow for balance of cut*

The Duplex HI-LO Control enables the flame cutting machine operator to vary preheat oxygen and fuel gas during the cutting operation . . . from a heavy preheat at the start to a lighter preheat once the cut is underway. Less oxygen and fuel gas are consumed.

Additional bonuses are faster starts and quality cuts free from melted-down edges and warpage.

The Duplex HI-LO is simple to operate, and moderate in cost. A Single HI-LO is also available for adjusting preheat oxygen only when low pressure fuel gas is used with injector-type torches. Both can be used with all Airco flame cutting machines.

For more information, call your nearest Airco district office or authorized Airco dealer. They are listed in the Yellow Pages under "Welding Equipment and Supplies."

AIRCO®

AIR REDUCTION SALES COMPANY

A division of Air Reduction Company, Incorporated

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BARBER COLMAN

Founded in 1900 for the purpose of building textile machinery, Barber-Colman Company today produces diversified equipment and products for such fields as automotive, aviation, machine tool construction and textile.

Versatile ACIPCO

centrifugally spun TUBES

...for super speed warpers

Barber-Colman Company, Rockford, Illinois, manufactures more than 85% of the section beam warpers produced in the world. And Barber-Colman specifies ACIPCO Centrifugally Spun Cast Iron Tubes as supplied through our mid-west distributor, C. A. ROBERTS CO.

The Super Speed Warpers produced by Barber-Colman have a winding speed of 900 yards per minute yet these units are also engineered for low and uniform tension to produce a beam in which thread ends are stressed alike.

Specifications for the machines are strict: tubular metal parts must be machined to a fine finish and to precise measurements. They must have high strength and be balanced so that they are capable of withstanding sustained high speeds. ACIPCO tubes **custom-fit** requirements such as these.

Centrifugally Spun ACIPCO tubes have a dense, non-directional grain structure which is easier to machine. Important, too, their **inherent** dimensional stability and concentricity makes dynamic balance easier to attain in finished products.

If your machines or products employ tubes of stainless steel, carbon steels, alloy irons, or special analyses as components, it will pay you to investigate ACIPCO. Call or write for complete information on ACIPCO tube applications in your field. No obligation, of course.

SIZE RANGE: Lengths up to 410″ have been produced to meet modern machinery requirements. OD's from 2.25″ to 50″; wall thicknesses from .25″ to 4″.

ANALYSES: All alloy grades in steel and cast iron, including heat and corrosion resistant stainless steel, plain carbon steel and special analyses.

FINISHED: As cast, rough machined, or finished machined, including honing. Complete welding and machine shop facilities for fabrication.

SPECIAL PRODUCTS DIVISION

AMERICAN CAST IRON PIPE CO.

BIRMINGHAM 2, ALABAMA

ACIPCO

Show, or *write* Heli-Coil Corp., a division of Topp Industries Inc., 954 Shelter Rock Lane, Danbury, Conn.

Microhardness Tester

YOU can check work easily and reliably with the Model LL microhardness tester. This unit has a relatively selective range of indentation loads from 25 to 1000 grams.

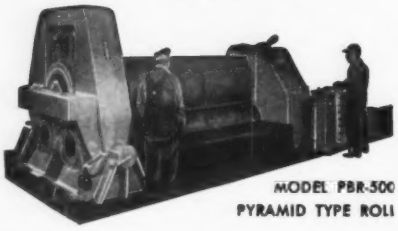
Items such as carbide tips on cutting tools, drill rods, and plated surfaces can be tested with the semiautomatic device.

You can see the tester at the Metal Show, or *write* Wilson Mechanical Instrument Div., American Chain & Cable Co., Bridgeport, Conn.

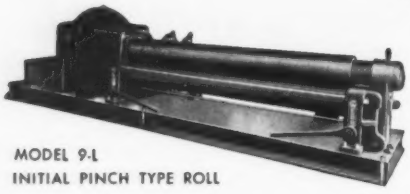
WEBB PLATE FABRICATING MACHINERY

PLATE BENDING ROLLS

The Webb Corporation offers a complete line of Plate Bending Rolls for the rolling of the thinnest plate up to plate 2½" thick. Offered in a variety of lengths and thicknesses. Constructed for the modern fabricating shop.



MODEL PBR-500
PYRAMID TYPE ROLL



MODEL 9-L
INITIAL PINCH TYPE ROLL

Two types available: the Initial Pinch Type and Pyramid Type machines. All latest advantages of today's modern machine tools are incorporated, utilizing anti-friction bearings, totally enclosed gear drives. Special forming rolls for culvert pipe, stock tanks and other special shapes available.

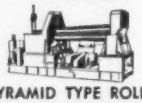
SLIP ROLLS

A complete line of small Sheet Metal Forming Rolls are also available. All power-driven with shaft sizes 3" to 5" for the handling of the thinnest gauge material, up to 8 gauge material. Special rolls for the forming of polished sheets, aluminum and stainless steels can be furnished. Complete catalogues on any size machine furnished upon request; write Dept. D.

SLIP ROLLS
UP TO 8 GAUGE PLATE

Let Speed PAY–The WEBB Way!

SLIP ROLLS



PYRAMID TYPE ROLL

INITIAL TYPE ROLL

STEELWORKERS

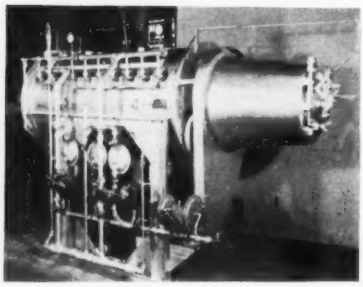
Also Manufacturers of INDUSTRIAL WEIGHING EQUIPMENT

Since 1881 THE WEBB® CORP.
WEBB CITY, MO., U. S. A.

Continuous Furnace Heat Treats Small Parts

SUCH PROCESSES as carburizing, case hardening, and clean hardening can be done without modifying the Model 136-MGD rotary retort furnace.

A new type automatic feeding hopper is used. The work is conveyed through the alloy retort by an integral internal spiral which advances the work through the heated zone. The work is discharged from the retort in the heating chamber through an atmosphere sealing hood. Capacity of the unit ranges from 150 to 400 lb per hour.



You can see this furnace at the Metal Show, or *write* American Gas Furnace Co., Elizabeth, N. J.

Tensile Tester Comes in Two Sizes

THE bench mounted tensile tester pictured on Page 219 has a maximum capacity of 10,000 lb. Other maximum capacities: 1000 to 40,000 lb. With a pair of hardened compression plates, the unit can also be used for compression tests.

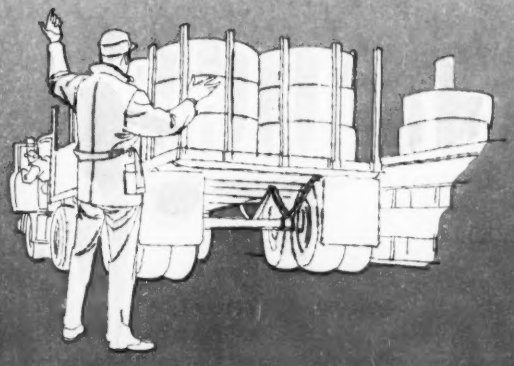
A portable model is available. Both types have several accessory sizes and styles of specimen holding jaws for a wide range of flat and cylindrical specimens.

You can see these testers at the

COOPERATION

is a SPECIAL service

at Alan Wood



From the time you first call in your Alan Wood Representative till the cold rolled steel is in your plant, complete cooperation by Alan Wood assures you of the right cold rolled steel for your production requirements. For example, your Alan Wood Representative may suggest a metallurgical study of your situation. He has full information on cold rolled steel and its application, and his advice on type, gauge and size to order can help you eliminate production problems... cut costs... increase profits.

Call your Alan Wood Representative today! He's always available... and ready to help.

ALAN WOOD STEEL COMPANY

CONSHOHOCKEN • PENNSYLVANIA

DISTRICT OFFICES AND REPRESENTATIVES:
Philadelphia • New York • Los Angeles • Atlanta • Boston • Buffalo • Cincinnati • Cleveland
Detroit • Houston • Pittsburgh • Richmond • St. Paul • San Francisco • Seattle
Montreal, Toronto and Vancouver, Canada—A. C. Leslie & Co., Limited

ANNOUNCING

GRANODINE 663

FIRST AUTOMATED IRON PHOSPHATE PROCESS! *and it's "cold," too!*

NEWEST PRE-PAINT TREATMENT FOR STEEL

AUTOMATED GRANODINE 663—the industry's first—takes the human element out of quality control . . . replaces it with 100 percent electronic line control, every hour of every day! You get positive, electronic vigilance on the line that adds up to savings in time, labor and chemicals—yet overall coating uniformity and quality never varies!

COLD GRANODINE 663—the coldest yet—means on-the-line savings of 50 percent or more in heating dollars! Typical heat savings range from up to $12,000.00 per year on large volume lines, to $7,500.00 and $5,000.00 yearly on intermediate and smaller spray lines when compared to the cost of typical hot processes.

Put your phosphate processing on a more productive basis with the first completely automated phosphating line in the metalworking industry. Write, wire or phone your local AMCHEM representative for further information on cost-saving, time-saving Granodine 663!

Write for Bulletin 1698 on Granodine 663—contains eye-opening quality control data that will interest your company's financial experts!

AMCHEM

Automated

GRANODINE

another chemical development of

AMCHEM PRODUCTS, INC., Ambler 27, Pa.

(Formerly American Chemical Paint Co.)

Detroit, Mich. • St. Joseph, Mo. • Niles, Calif. • Windsor, Ont. • Amchem and Granodine are registered trade marks of AMCHEM PRODUCTS, INC.

Check these Automated GRANODINE 663 Features...

- ✓ Automated—for round-the-clock quality and bath stability!
- ✓ Cold—for substantial heat savings!
- ✓ Lowest coating weight consistent with top quality!
- ✓ Powder-free coatings, continuous and adherent!
- ✓ Sludge-free bath!
- ✓ No oxidizing accelerators required!
- ✓ Readily soluble powder form, cheaper to ship, easier to store!

...and call your Amchem representative today!

AMCHEM

Automated GRANODINE

another chemical development of
AMCHEM PRODUCTS, INC., Ambler, Pa.
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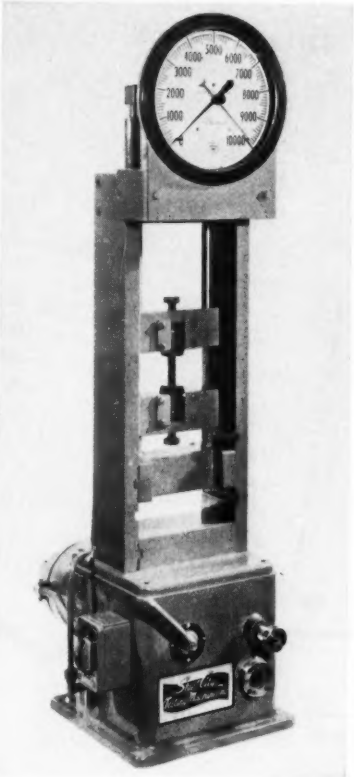
NEW PRODUCTS and equipment

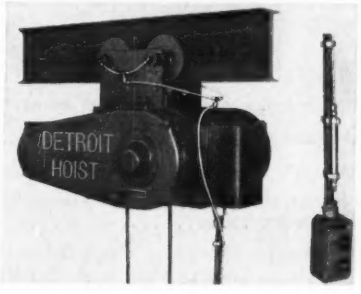


Metal Show, or *write* Steel City Testing Machines Inc., 8817 Lyndon Ave., Detroit 38, Mich.

Lubrication Kit for Hoist Makes Maintenance Easier

OVERHEAD hoists can be lubricated from the floor (even while in use) with systems such as the Safe-Lub kit. Lubrication is faster, easier, and safer with the system, says the manufacturer. Procedures such as ladder climbing and working near open monorail conductors are eliminated.

Locating fittings on the pendant control encourages maintenance at more frequent intervals. Nylon tubing connects the fittings to the overhead trolley wheel bearings.



The kit can be installed on any type overhead hoist.

For further information, *write* Detroit Hoist & Machine Co., 8201 Morrow St., Detroit 11, Mich.

Stronger Firebrick Conducts Less Heat

HIGHER strength and lower thermal conductivity are claimed for Babcock & Wilcox K-20 and K-23 firebrick. Mechanical strength has been increased more than 65 per cent for the K-20 and more than 50 per cent for K-23. Hangers or pins can be fitted without danger of breakage.

Other advantages include better mortar bonding, resistance to gas erosion, and easy shaping and cutting on the job. Ordinary woodworking tools can be used. Average weight of the K-20 9 in. straight is 1.7 lb. The K-23 9 in. straight averages 1.85 lb.

For further information, *write* Refractories Div., Babcock & Wilcox Co., 161 E. 42nd St., New York, N. Y.

Reciprocating Unloader Comes in Two Models

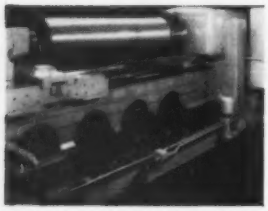
PRESS RAM movement controls a line of tray type reciprocating unloaders. The variable stroke unit removes parts and blanks from mechanical presses.

The tray slides underneath the die during the upstroke and receives the part or blank. During the downstroke, the tray emerges with the part which slides off into a bin (or onto a conveyor).

You can obtain either a rack or cable driven model. The full tray cycle in the rack driven model is actuated by a rack mounted to the press ram. The cable driven model has the tray-in stroke energized by a steel cable attached to the press ram and the out-stroke powered by an air cylinder. Tray drive mechanisms are interchangeable.

Change gears are available to vary the tray stroke from 10 to 20

(*Please turn to Page 222*)



Chip flow to the rear of the machine for easy removal.

36 spindle speeds in a range of 8 to 1000 R. P. M.

Four-way variable speed power rapid traverse.

Power tailstock positioning on flame hardened bed ways.

No chip pan obstruction at front of machine.

Tailstock design permits setting compound rest parallel to work axis.

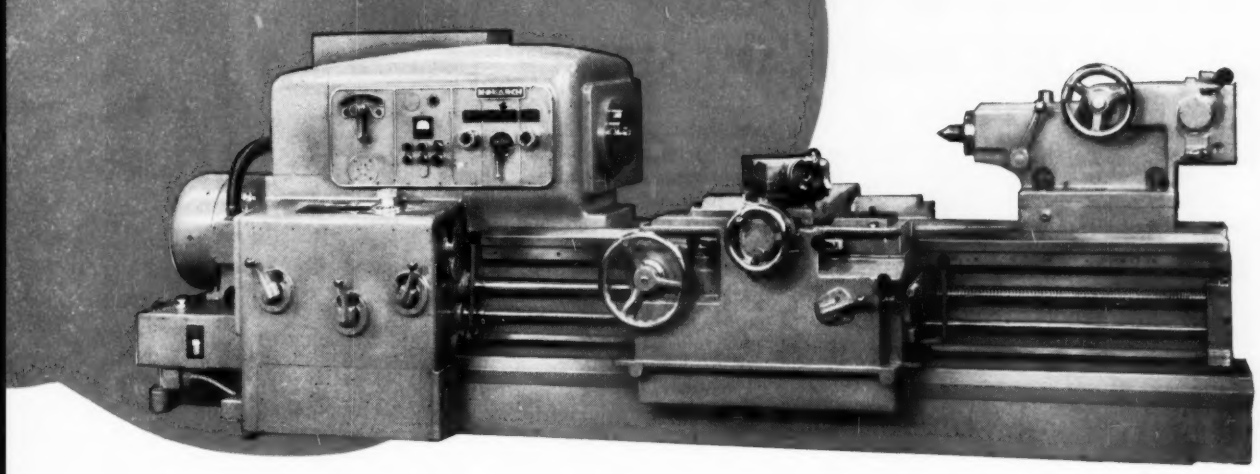
Check the Model 3220, feature for feature, against any other heavy duty lathe of similar swing capacity. Here are the major plus values. Add them up and you get only one answer — greater productivity hour after hour — day after day — year after year. This is worth investigation!

	Monarch Model 3220	Other 25" Or Model 3220 Machines
Number of spindle speeds	36	?
Speed range	8 to 1000 R. P. M.	?
Surface cutting speed automatically calculated	Yes	?
Hole in headstock spindle	3 5/16"	?
Spindle jog	Automatic	?
Headstock lubrication	Mist	?
Attention-free hydraulic clutch and brake	Yes	?
Swing over bed and carriage wings	32"	?
Bed width	26½"	?
Totally enclosed end gearing	Yes	?
Four flame hardened and precision ground bed ways	Yes	?
Chip flow to rear for easy removal	Yes	?
Chip pan obstruction at front	No	?
Automatic traveling rod supports	Yes	?
Variable speed power rapid traverse to carriage and cross slide	Yes	?
Automatic disengagement of apron handwheel and cross feed dial during traverse	Yes	?
Apron handwheel and cross feed dial pick-up at same spot after traverse	Yes	?
Feed range	.003" to.1683" per rev.	?
Backlash eliminator when using taper attachment	Yes	?
Tailstock spindle diameter	6½"	?
Power tailstock positioning	Yes	?
Anti-friction tailstock spindle suitable for drilling, tapping and reaming	Yes	?
Tailstock design permits setting compound rest parallel to bed ways	Yes	?
Stock removal, cu. in. per minute, up to	92	?
Net weight of base length (48") machine	19,660 lbs.	?

YOU GET MORE...
YOU PRODUCE MORE

with the Monarch Series 80
Heavy Duty Dyna-Shift Lathe—Model 3220

(OLD DESIGNS DESIGNATED AS 25" LATHES)



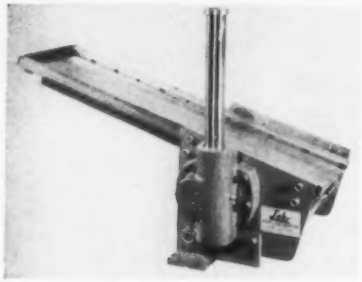
You'll suffer — competitively — if you tool up today with yesterday's lathes for the boom of the Soaring Sixties. The Monarch Series 80 is truly the lathe of tomorrow, as are the other new Monarch high production and special purpose lathes. Send for our illustrated Booklet #1603 for full Series 80 information — or state your other interests.

Monarch
TURNING MACHINES

THE MONARCH MACHINE TOOL COMPANY, SIDNEY, OHIO

IF IT CAN BE TURNED, THERE'S A MONARCH TO DO IT BETTER AND FASTER

NEW PRODUCTS and equipment



in. on small models with trays up to 36 in., and from 12 to 30 in. on large models having up to 72 in. trays.

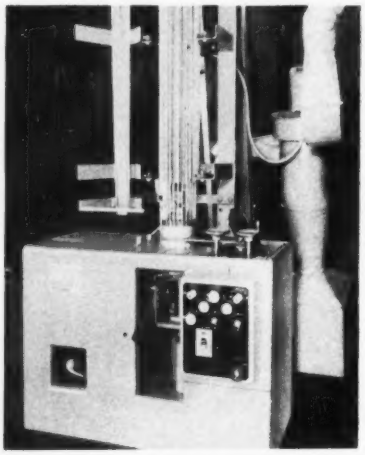
For further information, *write* Lahr Machine & Tool Co., 3404 Maplewood Ave., Toledo, Ohio.

Vertical Cutoff Saw

WITH this unit, you can cut several types of tubing and solids in various shapes at least ten times faster, the manufacturer claims. Materials (such as copper, brass, aluminum, or steel) up to 20 ft long are gravity fed.

Maximum production rate is said to range from 100,000 pieces per hour for 3/16 in. diameter tubing to 25,000 pieces per hour for 1 in. diameters. Burrfree lengths (1/4 to 7 in.) can be produced with closer than commercial tolerances. Handling methods cause no distortion of thin walled tubing.

Other advantages claimed are fast setup time; elimination of extra tooling (such as collets and mandrels for size changes); and longer saw blade life due to steadiness of feeding and reduction of twisting. Scrap losses can also be reduced because the unit can cut from smaller pieces.



The saw occupies a floor area of about 40 x 50 in. A completely enclosed saw blade and vacuum type chip collector provide operator protection. End pieces are automatically separated from finished pieces and dropped out the scrap chute at the rear.

For further information, *write* National Copper & Smelting Co., 1862 E. 123rd St., Cleveland 6, Ohio.

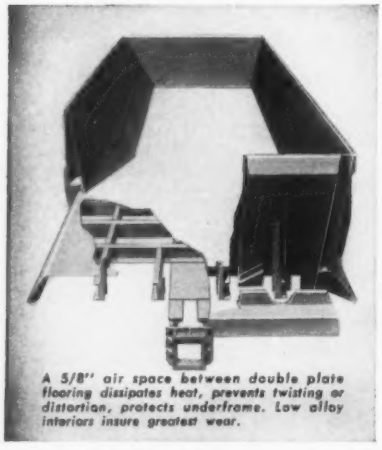
Machine Marks, Grooves Tubes Automatically

WITH THE Model 523 roll forming and marking machine, you can roll an annular groove around tubular parts and include identification and part number markings at a production speed of 5000 per hour.

A single roll forming die does the job without an internal support

MAGOR AIR DUMP CARS

FOR STEEL PLANT SERVICE

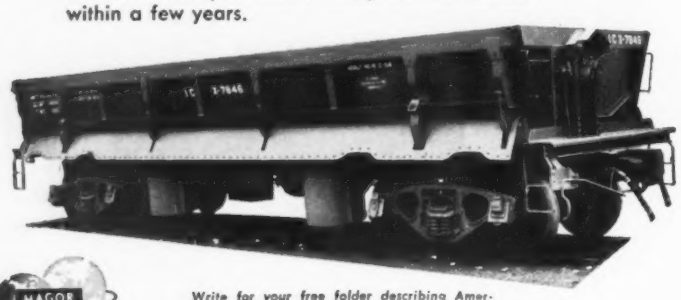


A 5/8" air space between double plate flooring dissipates heat, prevents twisting or distortion, protects underframe. Low alloy interiors insure greatest wear.

The new Magor Air Dump Car for steel plant service can cut your refuse disposal costs as much as 40%! Safe, swift, automatic dumping eliminates expensive labor and crane equipment. Low height and open type body means faster loading. Saves time, labor and haulage costs! Smooth interiors eliminate "dead load" returns!

The double-plate flooring shown here is just one of the many Magor design features that account for Magor's leadership in dump car production. Designed for the job — built to last, Magor Air Dump Cars cost less to buy — less to operate!

Savings effected by the new Magor Air Dump Cars will write off your entire dump car investment within a few years.

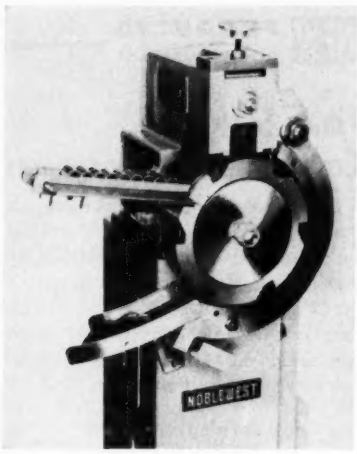


MAGOR

Write for your free folder describing America's number 1 air dump car, today!

MAGOR CAR CORPORATION

50 Church Street
New York 7, N.Y.



or a female die and with no distortion of the completed piece.

The machine has a continuously rotating work dial assembly. It rotates in a clockwise direction, picking up the work from an inclined gravity feed chute. The piece is carried through a station where steel dies roll in the desired markings. As the part continues through a segmental 17 in. circular grooving tool, it is rotated between a driving roll and the grooving tool. The part is ejected at the bottom of the work dial.

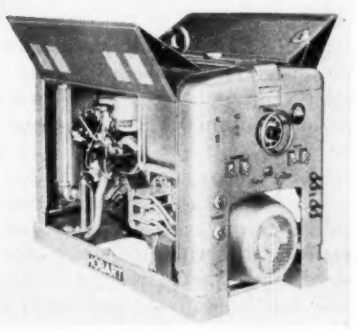
The dieholder is mounted on an eccentric stud for proper positioning of various diameters and depth of groove.

For further information, *write* Noble & Westbrook Mfg. Co., East Hartford, Conn.

Arcwelder-Power Unit Can Be Taken to Job

TUNGSTEN, inert gas shielded arcwelding can be done in the field with the Hobart gasoline engine driven combination arcwelder and power unit.

The unit has one engine and generator and can provide current for either ac or dc welding. Ratings are 250 amperes, 30 volts for dc welding and 300 amperes, 30 volts for ac welding (both ratings on 100 per cent duty cycle).



As a welder-power combination, it can be used as a source of single phase, 110/220 volt ac power of 10 kw capacity (up to 3 kw available while welding). Also while welding, you can have 1 kw, 110 volt dc auxiliary power.

Multiple current from the generator is made possible by a stator with two windings. One generates ac welding current; the other generates ac power current (single phase, 3 wire, 110/220 volts).

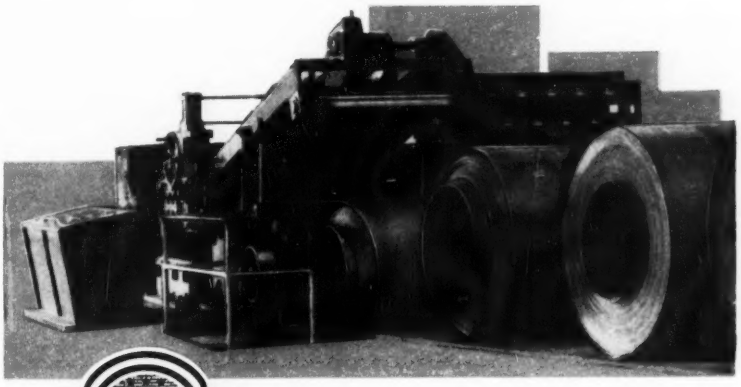
A tapped ac reactor and rheostat controls the ac welding current. In dc welding, the ac current is rectified by a silicon rectifier and smoothed out by a series dc reactor.

For further information, *write* Hobart Bros. Co., Troy, Ohio.

(*Please turn to Page* 224)

Stamco **heavy gauge feeding equipment and trimmers** save you money.

Saves operating time and increases production. A single operator can quickly feed gauges up to ½" thick with Stamco electrically and hydraulically operated coil strippers and unwind equipment.



Stamco, Inc.
New Bremen, Ohio, U. S. A.

Slitting and Coiling Lines • Cut-To-Length Lines • Flying Shear Lines • Power Squaring Shears • Automatic Resquaring • Corrugating, Culvert and Steel Mill Equipment

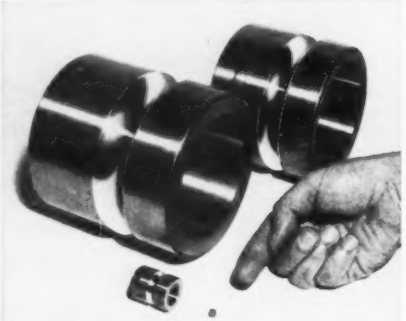
WHY MICROHONE*

YOUR CRITICAL ANTI-FRICTION BEARING SURFACES? BECAUSE...

Bearing loads and speeds, in common use today, demand critical bearing surfaces that are accurate, have correct geometry and proper surface finish. Also, the process that generates these surfaces must keep production costs to a minimum.

MICROHONING INCREASES PRODUCTION

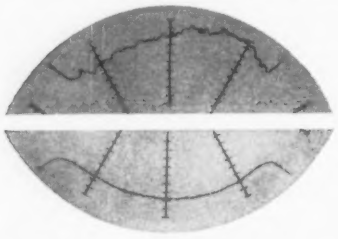
Microhoning is the first successful method for automatic processing and handling of raceway rings on multiple machines. It increases production several times over output of former methods.



Raceways of inner and outer rings for ball diameters ranging from .062" to 1.50" are currently being Microhoned.

MICROHONING IMPROVES BEARINGS

The ability of Microhoning to greatly improve the functional characteristics of critical bearing surfaces is even more significant. For instance . . . quieter-running, longer-life ball bearings are obtained because Microhoning of races assures:



Comparative Talyrond charts—each division of radial lines equals 50 millionths of an inch. Top: raceway curvature of a finished, unhoned precision bearing. Bottom: curvature of Microhoned raceway.

1 Improved concentricity between raceway and bore;

2 Removal of humps in raceway and trueing of plane of track;

3 Correct track curvature for greater contact with balls;

4 Simultaneous improvement of accuracy and surface finish.

Critical checking on precision instruments, and comparative performance studies have convinced many bearing makers and users that Microhoned bearings run smoother, quieter, and longer than those processed by any other method.

**Registered U.S. Pat. Off.*

For further information, write to:

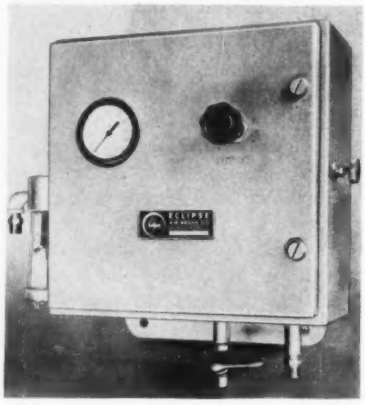
MICROMATIC HONE CORP.

8100 SCHOOLCRAFT AVENUE · DETROIT 38, MICHIGAN

NEW PRODUCTS and equipment

Timer Suited for Contaminated Atmospheres

THE Eclipse timer (compressed air operated) can be quickly installed on automatic or semiautomatic spray equipment. In addition to handling spray painting cycles (½ to 30 seconds), the unit can control other operations in explosive, abrasive, or corrosive atmospheres.



The timer is actuated by an air impulse from a manual or cam operated valve supplied with the unit. The cycle is repeatable within 10 per cent regardless of variations in the initiating pulse.

For further information, *write* Eclipse Air Brush Co., 390 Park Ave., Newark 7, N. J.

Lubricant Withstands Heat Up to 1900° F

YOU can use Almasol lubricant No. 1250 to withstand heat up to 1900° F. Heat, acid, and pressure resistance qualities are reported to be good.

The Almasol ingredient (magnesium silicate) forms thin sheetlike layers of natural lubricant between the film of oil and the metal surface. The first layer bonds itself to the metal surface, while the molecular structure causes other layers to slide horizontally across the bonded layer.

The company also says:

The bonded layer is a permanent shield against acid corrosion; the material will withstand great pressures and does not react with ferrous metals; corrosion problems are

eased with the inert and water insoluble material.

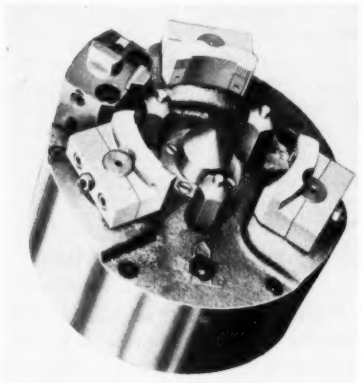
For further information, *write* Lubrication Engineers Inc., 2809 Race Ave., Ft. Worth, Tex.

Power Chuck Features Rigidity, Accuracy

GREATER rigidity and accuracy in chucking parts (for multispindle turning and boring) are cited for the Ball-Lok power chuck with ball joint actuation. A linkage ratio of up to 5:1 generates a tremendous gripping power, says the company. Minimum friction loss is claimed.

The actuating mechanism is completely lubricated and sealed to eliminate wear due to chips and other foreign matter. Jaw segments are reversible, interchangeable, and can be serrated or furnished with inserts.

You can get them for both external and internal applications in standard sizes (10, 12, 15, and 18 in.) Special sizes are available on request.



For further information, *write* N. A. Woodworth Co., 1300 E. Nine Mile Rd., Detroit 20, Mich.

Pegboard Panel Controls Milling Machine Cycle

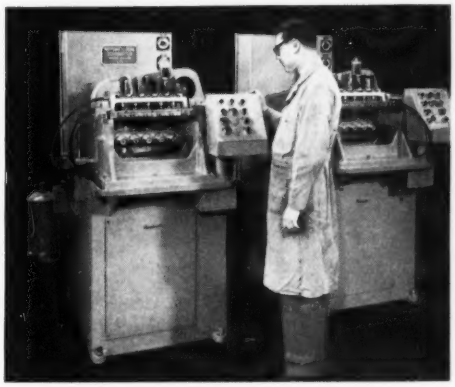
INSERTION of pegs into a pegboard control panel on the Telematic programs the milling machine cycle. The control (designed for the 200 Series Hypowermatic) handles all functions or movements of the machine plus auxiliary operations such as fixture clamping or indexing.

For each machine function, a row

HOW MICROHONING* OF CRITICAL BEARING SURFACES ASSURES QUIETER-RUNNING, LONGER-LIFE

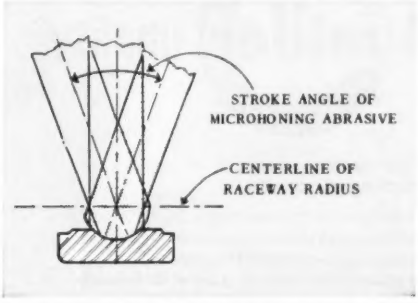
Because Microhoning is the first successful method for automatic processing and handling of anti-friction raceway rings on multiple spindle machines, production is several times higher than former methods.

In addition, here's how application of basic Microhoning principles (a combination of motions, low-velocity abrading, controlled pressure, float in tool) improve the functional characteristics of bearings: concentricity, track curvature, waviness, accuracy, surface finish.



Typical five-spindle machines for Microhoning bearing raceway. Typical production: bring high-band reading (Waveometer) of raceway waviness below one microinch, rms . . . five rings in a 20-second cycle.

Tools are positioned on an oscillating bridge so that abrasive sticks pivot about the centerline of raceway arc to generate a true radius. As rings rotate, irregularities are removed from track leaving a clean surface that is free of smeared or deformed metal. During final seconds of Microhoning cycle, speed of oscillation is automatically reduced to generate a lay pattern that runs circumferentially around the track.



Because abrasive stick pivots about centerline of raceway while rings are rotating, Microhoning improves raceway curvature, waviness, surface roughness and lay.

Microhoning technique can also be applied to raceways of cylindrical roller, tapered roller, needle, thrust and self-aligning bearings . . . also, other critical bearing surfaces.

For further information, write to:

**Registered U.S. Pat. Off.*

MICROMATIC HONE CORP.
8100 SCHOOLCRAFT AVENUE · DETROIT 38, MICHIGAN

of 24 holes allows the operator to peg in cycles involving up to 24 steps (panels with more than 24 can be supplied). Templates can be prepared with holes for only those functions required for a specific job. A stepping switch scans the board and initiates actions indicated by the pegs.

Machine functions that can be programed include table right or left, table or carrier rapid, spindle carrier up or down, constant feed for accurate stop, dwell, quill advance, tracer control, spindle rotation, fixture control, and reset.

For further information, *write* Cincinnati Milling Machine Co., 2701 Marburg Ave., Cincinnati 9, Ohio.

Static Power Adjustable Drive Quiet, Reliable

HIGH RELIABILITY and quiet operation are cited for the Square D adjustable voltage drive. Magnetic

amplifiers and semiconductors are used for control and rectification of input power. Fail-safe circuits are used throughout.

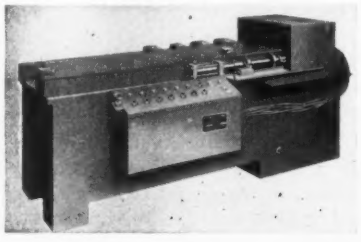
The drives are available as standard packages in sizes ranging from ½ to 200 hp, and have an 8:1 speed range with 5 per cent regulation. Standard modifications include dynamic braking, reversing, jogging, and dynamic slowdown. You can get special modifications for such applications as machine tools, conveyors, and other types of continuous process lines.

For further information, *write* Square D Co., 4041 N. Richards St., Milwaukee 12, Wis.

Circular Saw Does High Production Cutting

OPERATION of the Model V-4 circular saw is automatic. It can handle high production cutting of aluminum and brass extrusions, bar stock, and tubing. Capacity is 4 x 4 in.

It can be set up (using pushbuttons) to feed automatically by holes or other characteristics stamped into the materials. On automatic operation, pilot lights show steps within the automatic cycle. The saw cycles



the economy of miller quality

....becomes evident after sufficient exposure to the original cost/maintenance costs/production/profits equation.

Exploiting the full potential of better basic design, the Miller Gold Star 300 series ac-dc welders convert in minutes from the prime ac-dc welder of exceptional performance to any of these three A-C applications: Metallic Arc, manual or automatic Inert Gas; or, to any of the following D-C applications: Metallic Arc, manual or automatic Inert Gas, or Inert Gas spot welding.

It's important to note that the Miller conversion kits utilized to obtain any of the above simply extend the built-in superiority of the 300 series' welding characteristics into the type of application desired. It's adaptable by design — not discovery.

Available in 200, 300, 400 and 600 ampere models, all feature the exclusive Miller transformers and semi-metallic rectifiers. Complete specifications, including duty cycle chart, will be sent promptly upon request.

miller ELECTRIC MANUFACTURING COMPANY, INC., APPLETON, WISCONSIN

• Distributed in Canada by Canadian Liquid Air Co., Ltd., Montreal

1 to 20 times per minute. Speed is relative to length of projection and material being cut.

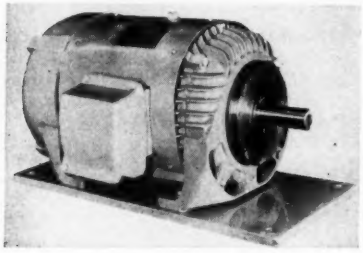
A 5 hp motor powers the 16 in. blade. Rim speed is 7000 rpm. You can get special accessories.

For further information, *write* W. F. Wells & Sons, Three Rivers, Mich.

Wheelhead Motor Suitable For High Precision Use

A PRECISION wheelhead motor for precision work (as grinding wheel applications) is obtainable in frames 213 through 256-U (totally enclosed, fan cooled).

Standard NEMA mounting dimentions are used.



The motor isolates 120 cycle vibrations and prevents blemishes from this cause. The rotor is balanced to 0.0001 in. Final balancing can be done without disassembling the unit. Maximum shaft runout is held to 0.00025 in.

For further information, *write* Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

Regulating Wheels Improve Centerless Grinding Work

PRECISION grinding to closer tolerances and smoother finishes with no chatter marks can be done with the Simonds-Worden-White line of regulating wheels.

They're designed for use in all types of centerless grinding operations. The wheels are made of aluminum oxide (with a rubber bonding agent). Type 1, 5, and 7 wheels are available in sizes from 8 to 14 in. in diameter.

For further information, *write* Simonds-Worden-White Co., 1101 Negley Place, Dayton 7, Ohio.

Detergent Makes Stubborn Buffing Compounds Yield

BUFFING compounds can be removed from metals without attack with Kenvert Sluff-Off X in soak or ultrasonic cleaning. The product is a water soluble detergent designed to remove compounds which are high in tallow or where oily conditions are encountered.

Metals that can be cleaned include steel, copper, brass, aluminum, nickel, silver, and zinc diecastings. It's effective on stubborn compounds which have impacted overnight or on weekends, says the company. Compounds from zinc and aluminum (which have combined chemically to form metallic soaps) can be readily removed. Treated ferrous parts tend to resist rusting.

The detergent can also be used for removal of soldering fluxes. Energy transmission qualities are good in ultrasonic cleaning applications.

For further information, *write* Conversion Chemical Corp., Rockville, Conn.

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ROHCO developments in powder conversion coatings offer a wide variety of low cost finishing effects—Brightening, Corrosion Protection and Paint Bonding—for:

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RODIP ZN-22—A one dip (no leach) process that imparts a clear, blue-white coating. Protects from fingerstaining, discoloration and corrosion.

RODIP ZN-23—New, inexpensive one dip (no leach) process. Produces a somewhat whiter coating than ZN-22 with a higher degree of chemical polishing.

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RODIP ZN-25—A one dip (no leach) process which produces a definitely bluish coating.

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RODIP CD-3—For still, automatic or barrel cycles. Easily operated (no leach) coating. Produces bright clear, stain-free finish with good corrosion protection.

RODIP CD-4—Primarily for rapid manual operation. No leach. Imparts a new, brilliant, clear, stain-free finish with good corrosion protection.

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RODIP C-10—Delivers a coating ranging from light golden to a deep bronze or brownish. Provides the ultimate in corrosion protection. Excellent for painting.

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RODIP AL-50—A new, extremely protective coating that gives a light golden to deep tan or brown color range.

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If your plant has 20 tons or more metal turnings per month, this booklet will tell you how you can make a substantial yearly profit.

Metal turnings reduced to shoveling chips in an American Metal Turnings Crusher command $2 to $4 more per ton on the scrap market. In addition, you save 75% of storage space and recover 30-50 gallons more cutting oil per ton of turnings.

This booklet shows all models of American Metal Turnings Crushers with capacities from 2 to 50 TPH as well as installations showing conveyor systems, crushers and chip wringers.

Write today for Bulletin 159. It will pay you to have an American Metal Turnings Crusher in your plant.

American PULVERIZER COMPANY
ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS
1539 MACKLIND AVE. ST. LOUIS 10, MO.

NEW literature

Write directly to the company for a copy

Specialty Steel Buyers Guide

A 40 page guide for buyers of specialty steels contains information on tool and die steels; stainless steels; high temperature alloys; electronic, magnetic, and electrical alloys; special purpose alloy steels; tubing and pipe, and fine wire specialties. Carpenter Steel Co., 339 W. Bern St., Reading, Pa.

Interrupting Capacity Chart

A revised chart (SA-8163-A) enables users of circuit breakers to select and order the proper breaker for each application. New breakers included have been designated as the JK, JKL, and the four Mark 75's. Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

RTV Data

Bulletin CDS-170A, 12 pages, contains product and application data on a complete line of room temperature vulcanizing (RTV) silicone rubber compounds. Silicone Products Dept., General Electric Co., Waterford, N. Y.

Speed Reducer Catalog

A 65 page catalog covers Ohio Gear's "Hi-Line" series of speed reducers. Ohio Gear Co., 1333 E. 179th St., Cleveland 10, Ohio.

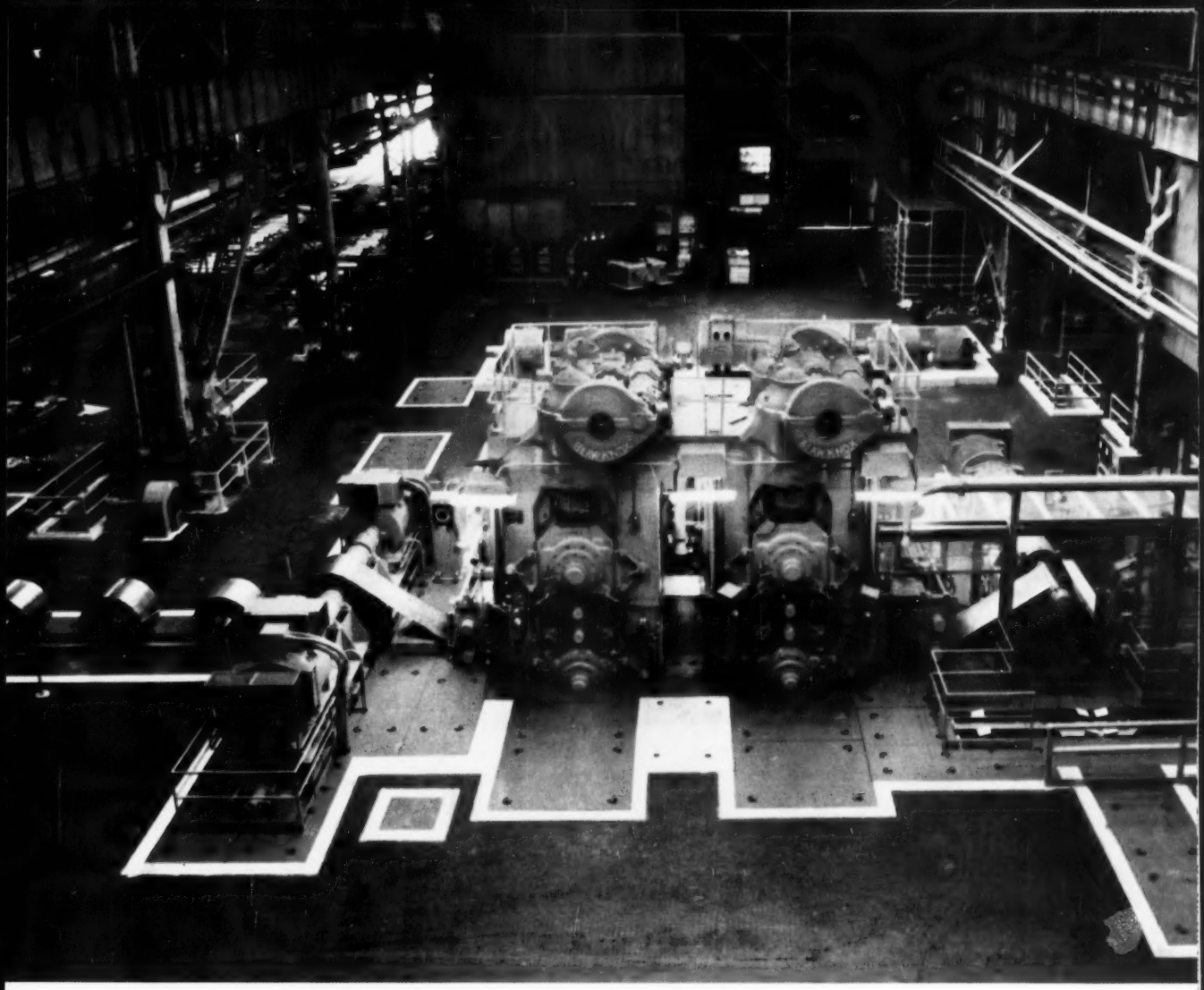
NEW BOOKS

Metallizing Handbook, Metallizing Engineering Co. Inc., 1101 Prospect Ave., West Barrie, N. Y. 345 pages, $5

This text is a valuable reference for anyone concerned with product design, materials engineering, machine maintenance, or corrosion protection of iron and steel structures. In addition to its "how-to" information, it includes the latest developments in spraying of high melting point ceramics, such as alumina and zirconia, and hard-facing alloys including tungsten carbide. New automated spraying equipment (electronically controlled for high speed, production line spraying) is treated in detail.

Practical Ironmaking, G. D. Elliot and J. A. Bond, Publications Dept., United Steel Companies Ltd., 17 Westbourne Rd., Sheffield 10, England. 276 pages, $6

Here is a book that will help and interest men who make their living in ironworking and senior students of ironmaking. The volume sets forth the principles in such a way that theory can be used to assist day by day operation. Its 19 chapters cover design, operation, and maintenance of the blast furnace, preparation of ores and sinter plant control, and ironworks refractories.



19- and 53-inch x 48-inch high speed 2-stand Temper Mill at the Fairfield, Alabama, works of the Tennessee Coal and Iron Division of the United States Steel Corporation.

BLAW-KNOX TEMPER MILLS

Blaw-Knox designs and builds a full range of two high and four high Temper Mills for integration into sheet, strip, and tin plate processing operations. Other Blaw-Knox equipment for the metals industry includes complete rolling mill installations and auxiliary equipment for ferrous and non-ferrous metals, sheet and strip processing equipment, electrolytic tinning, annealing, and galvanizing lines, seamless pipe and tube mills, draw benches, and cold draw equipment, Blaw-Knox Medart cold finishing equipment, iron, alloy iron and steel rolls, carbon and alloy steel castings, fabricated steel plate or cast-weld design weldments, steel plant equipment, and heat and corrosion resisting alloy castings.

BLAW-KNOX

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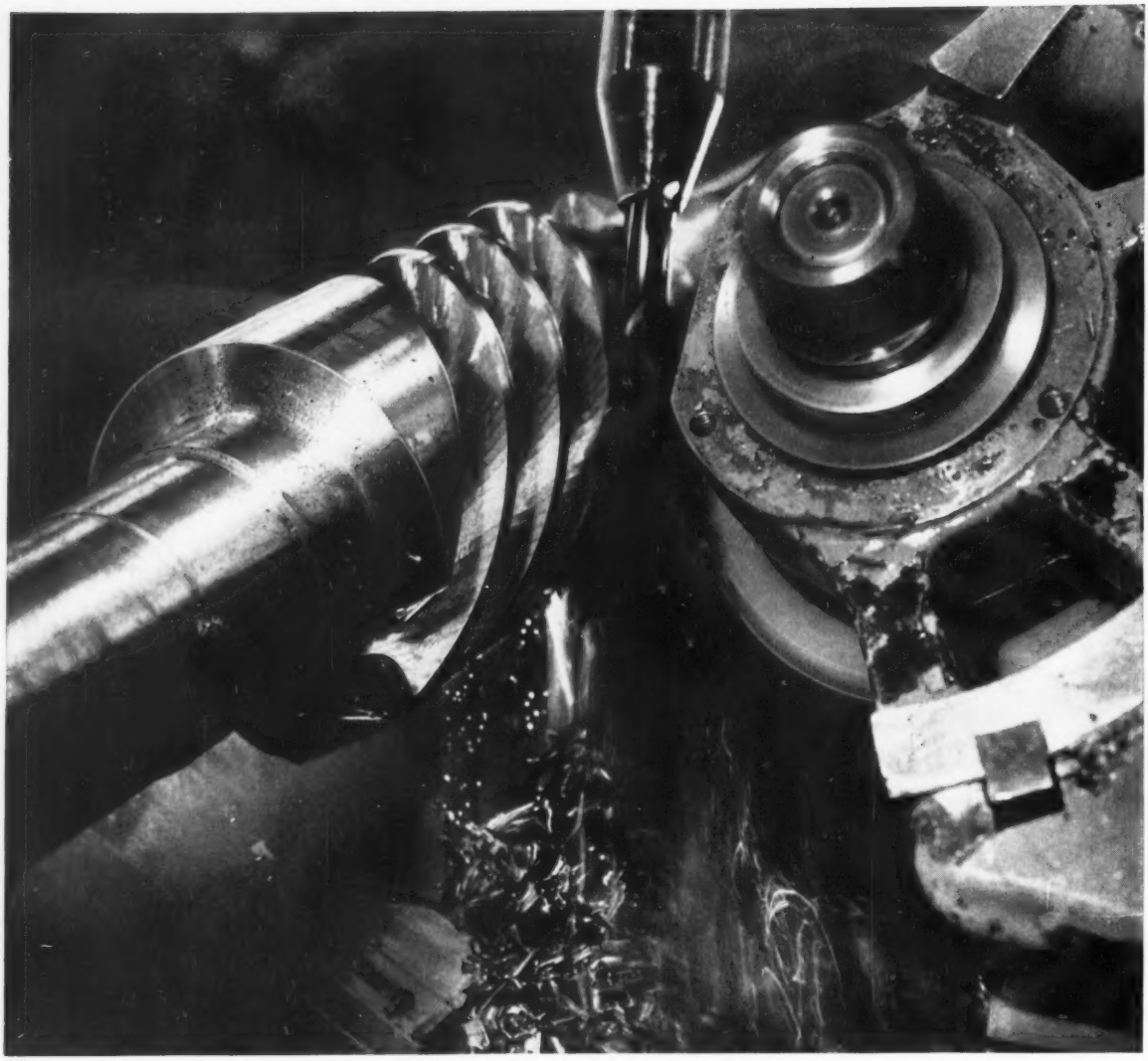

Aristoloy leaded user reports 25% reduction in time required to cut worm gear threads

Cutting threads on worm gears is an expensive, time consuming operation. Geometry is critical and a considerable amount of metal must be removed. One of the large manufacturers of "worms," desiring to increase production, found that by switching to a *leaded* steel* he could increase both speeds and feeds. Equally important, expensive cutting tools lasted longer because of the freer machining characteristics of leaded steel—delivering more pieces between grinds, and drastically reducing down-time for tool changes.

Strength and hardness tests on the finished part, after heat treating, indicated no detectable difference in physical properties from unleaded grades previously used.

For complete information about Aristoloy leaded or standard analyses carbon, alloy, and stainless grades, write for booklet entitled, "A Complete Line of Leaded Steels," and new Products & Facilities Catalog. *Inland Ledloy License

ARISTOLOY STEELS

COPPERWELD STEEL COMPANY

ARISTOLOY STEEL DIVISION • 4005 Mahoning Ave., Warren, Ohio • EXPORT: Copperweld Steel International Co., 225 Broadway, New York 7, N. Y.

October 26, 1959

Steelmakers Reveal Shipping Plans

UNCLE SAM is pulling his rank in the scramble for poststrike steel, but he's the only customer who's sure to get away with it. His requirements probably won't inconvenience you at all —unless you're in a bind for structurals or steel of the type used in pressure vessels.

Plates and structurals are needed at missile bases, but producers aren't sure how much is involved. Nor can they predict how many defense rated orders will cross their desks in the next few weeks. They'll be expected to fill all defense orders within 60 days of resumption.

FABRICATORS ON SPOT— Military requirements will undoubtedly derail some shipments that were destined for commercial use. That's bad news for structural fabricators because they could hardly get the steel they needed when they were competing with each other for dwindling supplies. Washington's "me first" edict means additional delays for construction work.

OVER-ALL IMPACT SMALL— All products considered, carbon steel producers estimate that less than 5 per cent of the tonnage they've booked is slated for military consumption. A large specialty mill says surprisingly little of its tonnage is subject to government priorities. Reason: About half of the tool steel and 40 per cent of the stainless producers were operating during the strike. They got most of the defense business.

HOW THEY'LL SHIP— On nondefense steel, the policy of the largest producers will be to fill orders by month and date of entry, shipping those scheduled for July and earlier first.

Smaller steelmakers indicate that they'll be more flexible. Entry date will be important, but it won't be the controlling factor in all cases. "Our district sales offices are keeping us informed about customer inventories," one steelmaker reports. "If a company that ordered early is in no danger of running out, we might bypass its order to accommodate someone who's in dire straits."

HANDLING BIG ACCOUNTS— Steel producers say size alone won't entitle users to special consideration. Case in point: Last January, one steelmaker warned a big customer to send in orders if it wanted to protect itself against a possible midyear strike. The customer delayed until April and May, then started to apply pressure. By that time, it was too late. Now, with inventories nearly exhausted, one of the customer's plants has been suggesting a conversion deal. When the steel company refused, top officials from the customer came in to press the issue. They got a polite but firm "no."

ROLLING CYCLES A FACTOR— In tubular products and structurals, rolling cycles may hold up some orders. Says a structural product manager: "When we clear up the July and earlier backlog for a certain section, we'll start rolling another shape instead of running ahead with August and September orders for the same shape." In tubular products, lack of July orders for a certain size may cause producers to move up some tonnage.

PRODUCTION GAINS— Last week, steelmaking operations continued to register 13 per cent of capacity. Production was about 368,000 ingot tons.

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*Current prices were published in the Oct. 19 issue and will appear in subsequent issues.

DIG INTO YOUR GREASE!

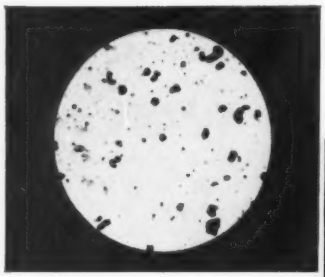
. . . you'll find you get greater MoS_2 coverage per dollar and a more uniform blend by adding Acheson dag® 208

Unless you look carefully, you may find it difficult to distinguish between greases made with different molybdenum disulfide additives. They may appear alike . . . even feel the same . . . but that's where the similarity stops. By actual photomicrographic comparison, the finer particles in 'dag' Dispersion 208 are your assurance of greater coverage . . . at no increase in solids content. Or, looking at it another way, equal coverage and greater effectiveness can be obtained at a much lower solids content, thus extending the range of application to even closer-tolerance mechanisms.

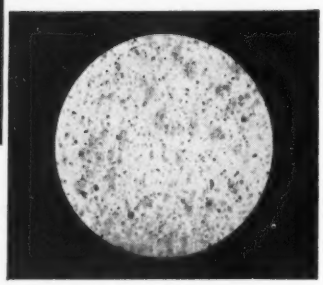
Because of the ease with which 'dag' 208 can be handled, measured and blended, there are additional savings in compounding time and labor. This stable dispersion assures the blender and the end-user of a consistently uniform grease.

If you are one of the many progressive *marketers* now considering adding a moly-fortified grease to your line, we urge you to evaluate 'dag' 208 today! If you are one of the many current *users* of moly-fortified lubricants, be sure to specify that the ones you purchase are formulated with Acheson's moly dispersions. Send in the coupon for a complimentary sample.

The same advantages of molybdenum disulfide can be incorporated in petroleum oils and polyalkylene glycol fluids. 'dag' Dispersions 200 and 207 are the finest colloidal concentrates available for these applications. Experimental samples may be obtained upon request.



Shown here is a dramatic comparison of particle sizes. Both Acheson's new dispersion, 'dag' 208, (below) and the finest commercially available molybdenum disulfide powder (at left), have been magnified 300 times.



Tests prove that the predominantly finer particles in 'dag' 208 (at right) provide 80% greater hiding power . . . more coverage per dollar.

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Please send me free of charge your trial sample of

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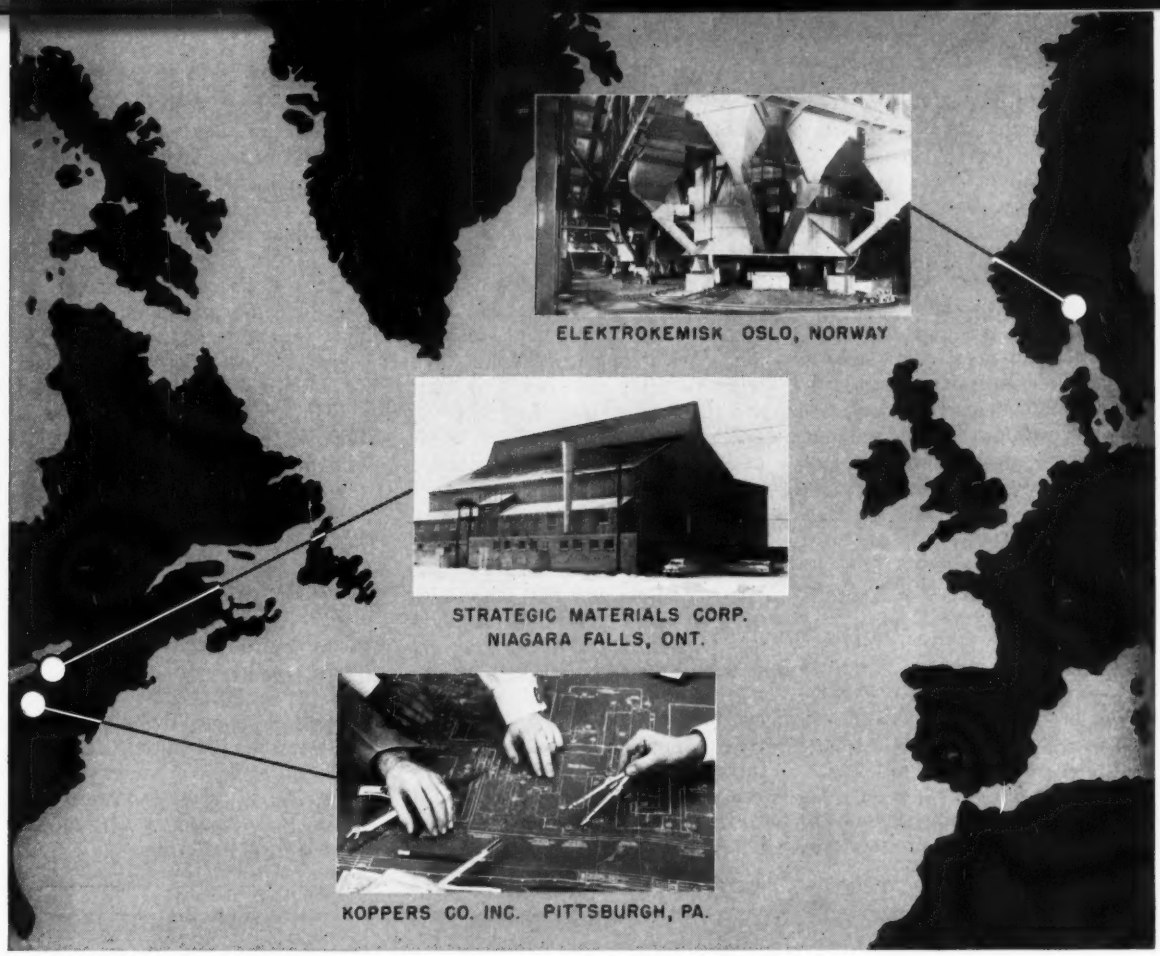


Three to Push Strategic-Udy Process

Koppers Co. and Strategic Materials Corp. strengthen position in direct reduction by expanding partnership. Third member, Elektrokemisk A/S, is a leading furnace builder

THREE engineering firms miles apart geographically are combining forces to exploit the world market for Strategic-Udy ore smelting plants.

Koppers Co. Inc., Pittsburgh, and Strategic Materials Corp., Buffalo (and Niagara Falls, Ont.), partners in development of the Strategic-Udy process since September, 1957, believe their recent affiliation with an electric furnace builder strengthens their position in the direct reduction field. The newest member of the combine is Elektrokemisk A/S (Elkem), Oslo, Norway.

Koppers and Strategic joined forces with Elektrokemisk because:

1. They wanted Elkem's experience in smelting furnace construction. In business since 1904, the company has installed or is building pig iron electric smelting furnaces with a total annual capacity of 2.2 million tons—more than 80 per cent of world capacity.

2. They hope to build plants all over the world. Elkem furnaces have been or are being built in Canada, Venezuela, Peru, Norway, Sweden, Finland, Switzerland, Spain, Portugal, Italy, Yugoslavia, Israel, India, Japan, and the Philippine Islands. The total: 23 installations, involving 52 furnaces.

• **Simple to Operate**—The process requires only standard material handling equipment, a rotary kiln, and an electric furnace. Iron ore, coal, and limestone are fed into the kiln, where partial reduction takes place. Then the kiln product—a hot, free flowing sinter—goes into an electric furnace where it's reduced to iron or semisteel. The metal is cast into pigs or transferred in molten form to another furnace for refining and further processing with alloying additions.

• **Advantages** — Koppers Co. says the process will especially appeal to underdeveloped countries. Reasons: 1. They have immediate and pressing needs for reinforcing

bars and light angles used in road building and apartment house construction. 2. Development of a domestic steel industry saves money on foreign exchange. 3. Local labor can be used in mining, transportation, and steelmaking. 4. Strategic-Udy plants can be built in small stages, with minimum capital investments. 5. Raw materials available locally can almost always be used. Substandard ores can be used without beneficiation. Contaminated ores can be used without affecting iron purity. Almost any carbon source (coal, lignite, coke breeze, or coke) can be used as a combined reductant and heat producer. 6. Economics are good at low levels of production.

• **What Partners Offer** — As developer of the process, Strategic Materials Corp. maintains elaborate testing facilities (a research lab at Niagara Falls, N. Y., and a prototype plant at Niagara Falls, Ont.) where customers' samples of iron ore, limestone, and carbon are sintered in a rotary kiln and reduced to iron in 1000 kva smelting furnaces. To date, more than 10,000 tons of ore have been processed. Although Strategic bills customers for the tests, it's primarily interested in receiving royalties when the process is used commercially.

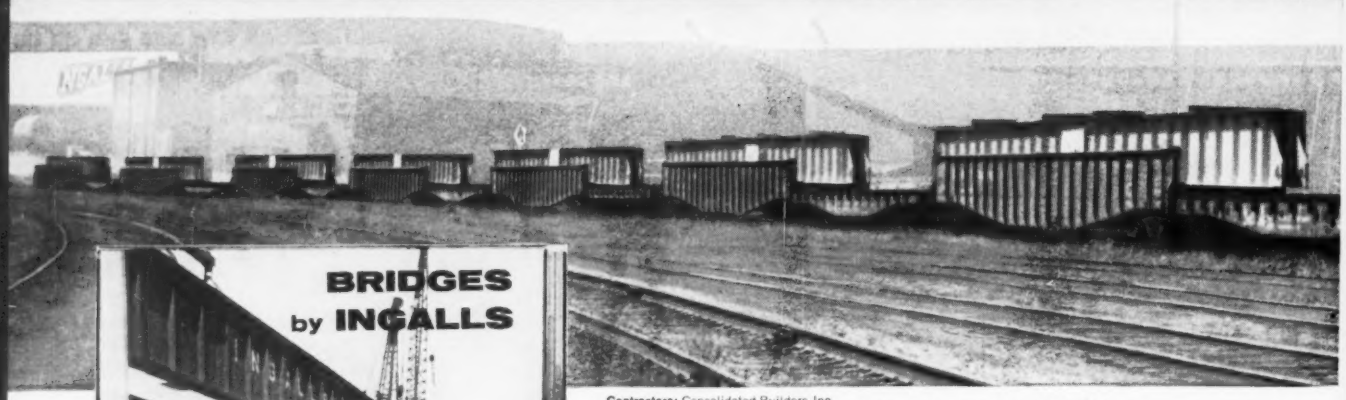
Koppers, licensed exclusively to design and build Strategic-Udy plants, offers a complete turnkey job. Says a company official: "We select a site; test raw materials and the physical-metallurgical properties of steel made from those materials (at Strategic's plant); estimate construction and capital costs; check labor and utility rates; determine transportation and production costs; and prepare market studies. In short, we develop a prospectus that could be taken to a financing group."

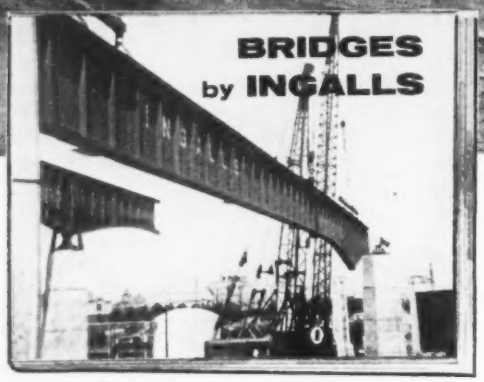
Koppers doesn't feel that promotion of the Strategic-Udy process contradicts its traditional interest in coke ovens, sintering, and blast furnaces. Reason: Direct reduction plants will probably be developed where conventional types could not be built. What's more, Koppers declares, birth of a primary steel industry in an underdeveloped country raises living standards, creates a market for high grade steel imports (like sheets), and stimulates demand for consumer durables.

• **On the Boards** — Although no Strategic-Udy plants have been built yet, at least two are on the boards. Quebec South Shore Steel Co., Montreal, Que., expects to build a plant at Varennes, Que. Annual capacity: More than 100,000 tons of pig iron and semisteel.

Webb & Knapp Inc., New York, recently formed Webb & Knapp Strategic Corp. to construct and operate an integrated steel plant at Clarkdale, Ariz. (STEEL, Sept. 28, p. 81). The mill will recover iron from the waste slag of an abandoned copper smelter and convert it to steel by the Strategic-Udy process. Koppers is doing the engineering and research. Webb & Knapp has also contracted to purchase large quantities of slag in Anaconda, Mont., from Anaconda Co. and to build a steel mill there.

16-CARLOAD "GIRDER EXPRESS"





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Contractors: Consolidated Builders Inc.
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Down the line rolled Ingalls' special "Girder Express" . . . on the job, and on time 4 days later . . . after a 1170 mile journey. Destination: Worcester Expressway Bridge, Worcester, Massachusetts.
Cargo: 32 Ingalls' steel fabricated bridge girders – each 93′ 3″ in length.

Wire . . .

Wire Prices, Pages 244 & 245

It's thought that the bulk of finished wire tonnage booked by the mills during the last three months will not be shipped until the first quarter of next year regardless of position on mill books. On other products, makers will give preference to defense rated orders in their schedules and will probably seek to take care of extreme hardship cases as quickly as possible.

In New England, much high carbon and specialty wire volume will be delayed until converters replace their depleted stocks of rods.

Getting back to normal production in most cases will depend on how soon semifinished steel is available.

Union Wire Rope Corp., Kansas City, Mo., has announced its wire rope products are now being sold through the Oil Field Sales Div. of National Supply Co., which operates 112 oil field stores in the U. S. and Venezuela and maintains 24 additional sales offices and agents around the world. Products covered in the agreement include rotary lines, cable tool drilling and casing lines, winch and dozer lines, rod and tubing lines, sand and pump lines, rod hanger lines, and slings. Both Union Wire Rope and National Supply are subsidiaries of Armco Steel Corp., Middletown, Ohio.

Steel Bars . . .

Bar Prices, Page 242

Shipments of cold finished steel bars by integrated mills will be heavier than those of converters or nonintegrated producers for a limited time after steelmaking operations are resumed. That's because converters and integrated mills are low on hot bar stock, while the integrated mills did not dip into either their hot or cold bar inventories for over three months.

Most tonnage immediately coming from the mills will be against old orders. The bulk of orders booked since mid-August probably will not be processed or shipped until the first quarter next year.

Raritan Arsenal, Metuchen, N. J., closes Nov. 3 on 145 tons of carbon and alloy bars.

Sheets, Strip . . .

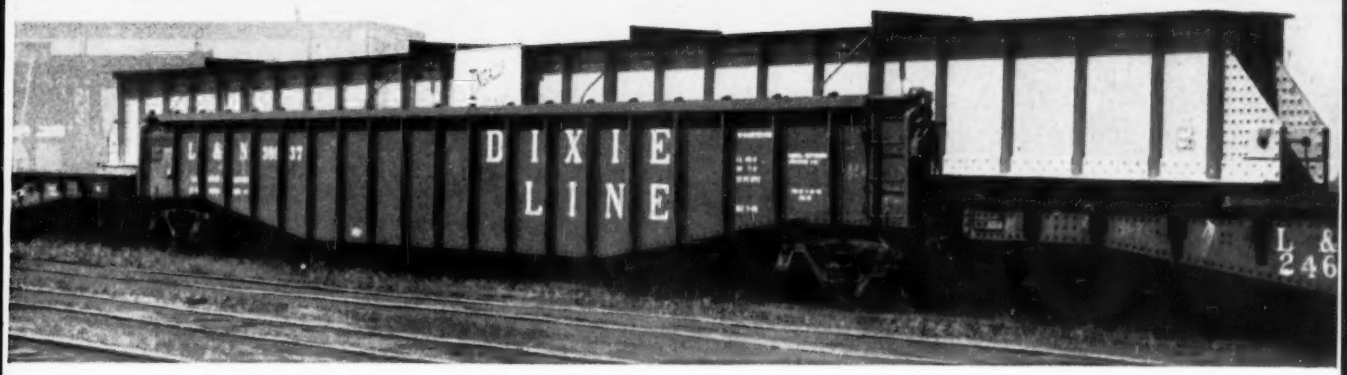
Sheet & Strip Prices, Pages 243 & 244

Sheetmakers are deluged with questions regarding the placing of new tonnage and the handling of orders already on their books. Tonnage is backed up since last July, and, in some cases, they have orders carried over from the second quarter.

The mills have enough inquiry on hand to assure full operations throughout the first quarter on hot and cold rolled and galvanized sheets.

Indications are producers will move slowly in setting up delivery schedules. Defense rated orders will get preference, and expectations are that extreme hardship cases will be taken care of as rapidly as possible. Formal delivery schedules probably will have to await the attainment

FROM INGALLS



Transportation of the huge girders required 8 heavy-duty flat cars and 8 of the longest gondolas in normal use.

Whether your next job calls for a carload or a trainload of fabricated structural steel . . . you're on the right track for first-class service, express deliveries, and economy rates when you call – Ingalls.

STEEL PLATE FABRICATORS ASSOCIATION FOUNDED 1931

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THE INGALLS IRON WORKS COMPANY
Executive Offices
BIRMINGHAM, ALABAMA

of fairly high level operations to permit orderly handling of backed-up orders. The chances are some sort of voluntary priorities may be necessary for a time.

Tin Plate . . .

Tin Plates Prices, Page 244

Shipments of metal cans in August totaled 614,764 tons vs. 502,476 in July and 593,158 in August, 1958, reports the Bureau of the Census. The total for the first eight months of the year was 3,307,452 tons vs. 3,150,632 in the like period last year.

Tubular Goods . . .

Tubular Goods Prices, Page 246

Well drilling activity in the U. S. declined during the week ended Oct. 12, a survey by Hughes Tool Co. shows. The national count stood at 2042 rotary rigs at work in the week, a decline of 97 from the preceding week. The total was still 70 rigs above the number operating in the corresponding week last year.

Oilmen are beginning to run out of tubing and casing, though critical shortages are still to be experienced, at least to the extent wholesale layoffs of workers are necessary.

Republic Steel Corp. has introduced a new line of buttress-thread casing claimed to economically support long strings of casings run in deep wells.

Foreign Steelmakers May Pull Out of U. S. Market

Substantial tonnages of foreign steel are available in the Southwest, but indications that European and Japanese mills may be conducting an orderly retreat from the U. S. market are growing.

A spokesman for a large mill in western Europe says more favorable markets are developing in South America. He speculates that rather than reduce prices when U. S. mills get back into production, his mill and others will divert their exports to South America and Asia.

Plates . . .

Plate Prices, Page 242

Plate demand has spurted—in specialties as well as carbon plates, and in light as well as the heavy gages.

Most distributors are out of light plates, and a strong seasonal demand for fuel tank requirements is noted. Plate fabricators' stocks are shrinking steadily. Job completions in many instances will depend upon the early receipt of tonnage from the mills.

Tool Steel . . .

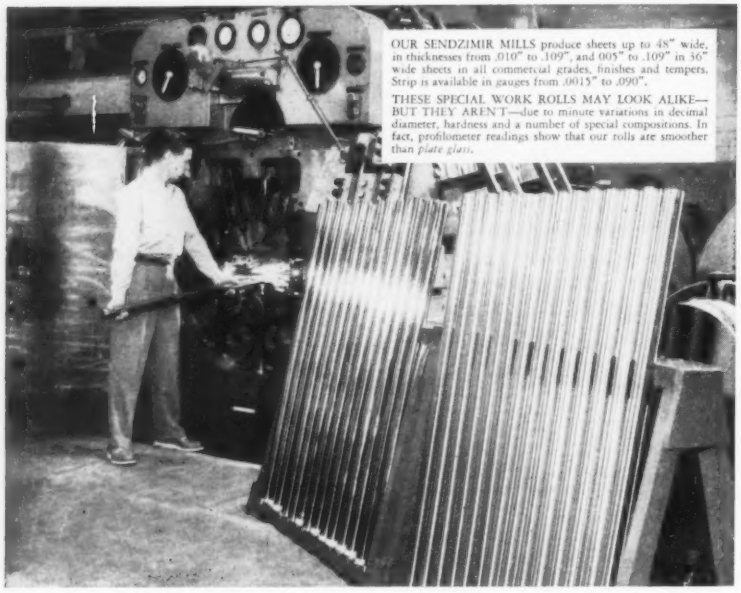
Tool Steel Prices, Page 246

Vascoloy-Ramet Corp., Waukegan, Ill., lowered prices on all of its supersteel cutting grades of carbides, including VR-77, VR-75, VR-73, EH, VR-87, and AW. Priced as Group 1, premium grades of carbides produced by the company now sell at standard grade prices.

Distributors . . .

Prices, Page 247

Distributors report a drop in bookings due to the shrinkage in available supplies, particularly of flat rolled products. Demand is heavy for most items and especially so for sheets, floor plates, and some sizes of structural shapes.


OUR SENDZIMIR MILLS produce sheets up to 48" wide, in thicknesses from .010" to .109", and .005" to .109" in 36" wide sheets in all commercial grades, finishes and tempers. Strip is available in gauges from .0015" to .090".
THESE SPECIAL WORK ROLLS MAY LOOK ALIKE—BUT THEY AREN'T—due to minute variations in decimal diameter, hardness and a number of special compositions. In fact, profilometer readings show that our rolls are smoother than *plate glass.*

It takes more than just a precision mill to produce* STAINLESS STEEL *of MicroRold® quality

. . . it takes Operating Know-How. Only Washington Steel, first to use Sendzimir sheet rolling, can offer you 10 years of practical experience with these mills.

Every hot-rolled stainless steel band has variations in thickness and surface characteristics which must be compensated for in the cold-reduction process to obtain precise gauge and flawless surfaces. To do this, special work rolls with minute diameter differences along the length of the roll are used in controlling such variations as crown, edge and camber. To accurately control all the possible variations requires a large number of these rolls, plus *highly skilled operators* who know from experience which rolls, speeds and reductions are required. These are but a few of important factors in quality rolling which can only be learned by *long* experience and association with precision mills.

Washington Steel is the only producer whose entire production stainless steel sheet and strip is rolled exclusively on the Sendzimir Mill.

WASHINGTON STEEL CORPORATION
102-0 Woodland Avenue • Washington, Pennsylvania

Some service centers which have been closed since July 15 have substantial stocks which will be released as soon as workers return to their jobs. Allocation to defense-rated orders and regular customers of these supplies will be strict.

Rails, Cars . . .

Track Material Prices, Page 245

Freight car orders declined again in September, totaling 945 units vs. 1753 in August and 1585 in September a year ago, reports the American Railway Car Institute and the Association of American Railroads.

Backlogs as of Oct. 1 totaled 18,658 cars on order in railroad shops and 16,968 in commercial shops, a total of 35,626 vs. 37,172 on Sept. 1, and 24,982 on Oct. 1 a year ago.

Farm Tool Makers Double Use of Ductile Iron

The farm equipment industry will double its consumption of ductile iron this year, according to Donald J. Reese, director, Ductile Iron Div., International Nickel Co. Inc., New York. Some 27,000 tons will be used in the industry this year vs. 12,000 tons last year.

Pig Iron . . .

Pig Iron Prices, Page 247

Foundries continue to operate at a fairly good rate despite difficulties brought on by the steel strike. They are buying pig iron steadily, getting all the tonnage they need.

Eastern Gas & Fuel Associates announced it is closing its Mystic blast furnace permanently. Reason: Demand for pig iron has declined in New England. The furnace, in operation since 1926, has capacity for 500 tons daily. A four-month stockpile of iron will be sold to contract customers.

Low phosphorus pig iron is being produced and marketed at Sorel, Quebec, by Quebec Iron & Titanium Corp., owned by Kennecott Copper Corp. (two-thirds) and New Jersey Zinc Co. (one-third).

The iron is produced in an electric furnace from ilmenite ore. Titanium slag is also produced. Capacity is about 300,000 tons of pig iron and 400,000 tons of slag annually.

Semifinished Steel . . .

Semifinished Prices, Page 242

Steel consumers see little chance of getting much tonnage from the reactivated steel mills for at least two weeks after ingot operations are resumed. Most of the early tonnage will be orders in-process at the time the mills were struck.

Because producers were shipping steel products at a higher rate than they were producing semifinished, stocks of semifinished are light, in many cases negligible. It will take time to fill up the pipelines. Some observers estimate that even after a month, when ingot operations may be running in excess of 90 per cent of capacity, the shipping rate of finished steel will be no more than 60 to 70 per cent.

Some producers believe they will be lucky if they are producing ingots at 40 per cent of capacity at the end of the first full week after resumption, 60 to 80 per cent at the end of the second week, and 80-900 per cent the next week.

Much depends on how much

WAPAK SLITTERS

Photo courtesy of Stamco Inc., New Bremen, Ohio

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Mirror Finish and ULTRA-KEEN EDGES reflect LOWER PRODUCTION COSTS

Longer continuous runs with less down-time are obtained with WAPAK Slitters and Rotary Shear Knives, because they're designed for high-speed cutting and trimming. Precision inspected by visual gage and profilometer.

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Use WAPAK MULTICUT for maximum production. WAPAK TUFCUT is engineered for shock-resistant cutting of heavy stock.

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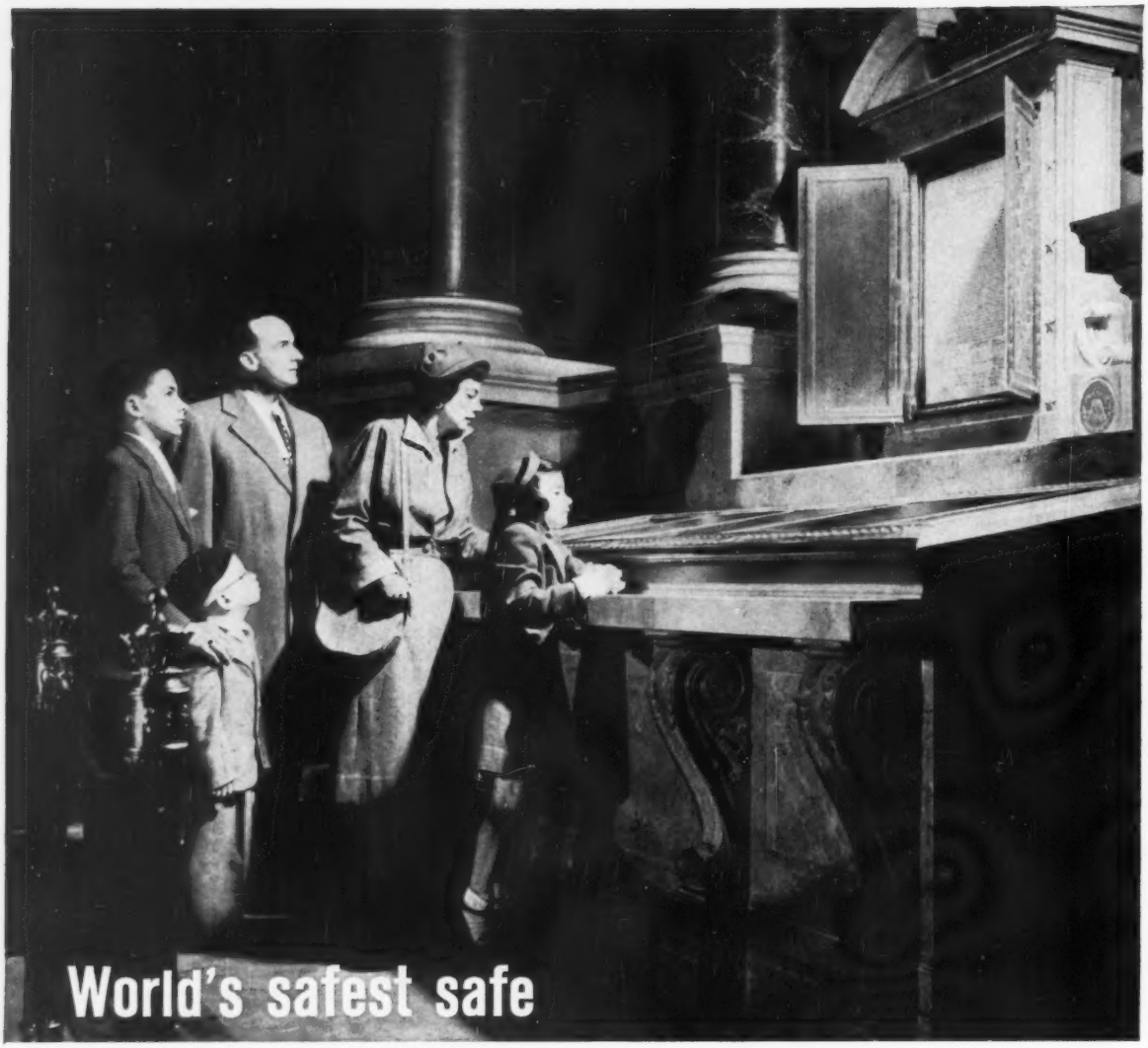

welded with M&T Murex electrodes

Guarding the nation's most treasured documents is a job entrusted to what is probably the world's safest safe. Nightly, or in emergencies, cases containing the Declaration of Independence, Constitution and Bill of Rights are automatically lowered into the safe which protects the documents behind mammoth self-locking doors. In its construction, the Mosler Safe Company depended on M&T Murex electrodes.

This is one of a whole host of vital jobs being done with Murex electrodes. Other examples: Behlen Frameless Metal Buildings, which have survived what is probably the world's toughest single test – a nuclear blast – rely heavily on welds with Murex electrodes in commercial, school and farm building construction. And for the world's best cars – those produced in the U.S. – more than one out of four is joined or unitized with reliable Murex welds.

So it goes. Where there is dependence on the integrity of welds, there is dependence on M&T Murex electrodes . . . and welding machines, too.

M&T offers one of the broadest lines of electrodes and wires for arc welding – over 1000 types and sizes; and a complete choice of welding machines. Ask the M&T man for details or recommendations. Or send for literature.

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METAL & THERMIT CORPORATION, General Offices: Rahway, New Jersey

damage to equipment has been suffered during the strike and whether there will be slowdowns by workers. It's thought that it will be close to a month before the mills will be able to call all the men back.

Under the circumstances, more cutbacks in manufacturing operations are expected before there is any noticeable improvement.

Structural Shapes . . .

Structural Shape Prices, Page 242

Resumption of operations at strikebound steel mills is expected to result in a pickup in demand for construction steel products. The uncertain supply outlook in recent weeks held up a number of new orders and delayed projects already underway.

Fabrication of much structural work now being placed will be slowed by the supply shortage.

Currently, delivery schedules on shapes are lengthening. Within the last two weeks some producers who have been entering orders on the basis of probable output after resumption of operations have extended their promises three weeks or more on many sections.

STRUCTURAL SHAPES . . .

STRUCTURAL STEEL PLACED

7865 tons, superstructure, bridge No. 8, 62nd St. Allegheny River, Pittsburgh, Contract 3, to American Bridge Div., U. S. Steel Corp., Pittsburgh.

565 tons, distribution center, Rumery Industrial Park, South Portland, Maine, to Bancroft & Martin Rolling Mills Co., South Portland; F. I. Merrill, South Portland, general contractor.

200 tons, Public School No. 128, Brooklyn, N. Y., to Bethlehem Fabricators, Bethlehem, Pa.

175 tons, compressor unit, Du Pont interests, Victoria, Tex., to the Campbell Steel Co., San Antonio, Tex.

150 tons, junior high school, Levittown, Pa., to American Bridge Div., U. S. Steel Corp., Pittsburgh.

150 tons, executive headquarters building, Raytheon Mfg. Co., Lexington, Mass., to Babcock-Davis Associates Inc., Boston; George A. Fuller Co., Boston, general contractor.

STRUCTURAL STEEL PENDING

3750 tons, 14th St. bridge over the Potomac River, Washington, D. C., bids Oct. 30.

700 tons, also 100 tons of reinforcing, Idaho State underpass, Washington County; bids to Boise, Idaho, Nov. 3.

575 tons, state bridgework, Dauphin County, Pennsylvania, bids Oct. 30; also 375 tons of reinforcing bars.

350 tons, substation steel, Creamer Industries, Ft. Worth, Tex., low at $109,348 to Bonneville Power Administration Portland, Oreg.

250 tons, three wide flange bridges, U. S. Route 4, Bridgewater, Vt.; also 120 tons of reinforcing bars.

250 tons, Union Ave. Bridge, Portland, Oreg. (state project); C. J. Montag & Sons, Portland, low at $360,466; award to be made Nov. 5.

180 tons, wide flange, General Stores Supply Office, Navy, Philadelphia; bids to be taken Nov. 13.

120 tons, addition, St. Mary's Hospital, Hoboken, N. J.; bids closed Oct. 15.

115 tons, two wide flange beam bridges, Newport-Troy, Vt.

REINFORCING BARS . . .

REINFORCING BARS PLACED

360 tons, distribution center, Rumery Industrial Park, South Portland, Maine, to Bancroft & Martin Rolling Mills Co., South Portland; F. I. Merrill, South Portland, general contractor.

310 tons, state highway structures, near Statesville, Iredell County, North Carolina, to Southern Steel Products Co., Atlanta; Wilson Construction Co. Inc., Salisbury, N. C., general contractor.

265 tons, men's dormitory, Georgia Institute of Technology, Atlanta, to Joseph H. Fox Co., Birmingham; J. A. Jones Construction Co., Atlanta, general contractor.

215 tons, state highway bridge, Waterville, Maine, to Bancroft & Martin Rolling Mills Co., South Portland, Maine; Frank Rossi, Gardiner, Maine, general contractor.

165 tons, three state highway bridges, Lowell, Mass., to Northern Steel Inc., Boston; Coleman Bros. Corp., Boston, general contractor.

160 tons, two dormitories, St. Anselm's College, Manchester, N. H., to Northern Steel Inc.; Davison Construction Co. Inc., Manchester, general contractor.

100 tons plus, Fulmer Chemistry Hall, Washington State College, Pullman, Wash., to unstated interest; general contract to Purvis Construction Co., Yardley, Wash., at $846,706.

REINFORCING BARS PENDING

2000 tons, also 83,467 ft of prestressed girders, and 45,000 ft of concrete piling, Washington State, three freeway bridges, Seattle; bids to Olympia, Wash., Nov. 17.

1500 tons, St. Regis paper mill, Tacoma, Wash.; general contract to Howard S. Wright Construction Co., Seattle.

634 tons, state bridgework, Monroe County, Pennsylvania; bids Oct. 29; also, 1000 tons of shapes required.

350 tons, reconstruction, eastbound section, Benning Road Viaduct, Washington; bids Oct. 27, Department of Highways and Traffic, District of Columbia; also 290 tons, structural steel.

310 tons, tunnels and chambers, OPS Center, Colorado Springs, Colo.; bids Dec. 1, U. S. Engineer, Omaha, Nebr.

273 tons, state bridgework, Indiana County, Pennsylvania; bids Oct. 29.

251 tons, state bridgework, Armstrong County, Pennsylvania; bids Oct. 29.

195 tons, structure, West Highway Bridge, near 14th Street, Washington; bids Oct. 30; also 16,260 linear feet steel H-beam piles if steel girder spans are used in superstructure; alternate on concrete girders, superstructure, require 165 tons of bars for substructure and 67,920 linear feet of steel H-beam piles.

150 tons, Seattle-Tacoma freeway extension, Washington State project; bids to Olympia, Wash., Oct. 24.

100 tons or more, 168 ft Montana State highway interchange; bids to Helena, Mont., Oct. 28.

RAILS, CARS . . .

RAILROAD CARS PLACED

Northern Pacific, 400 boxcars, to Pullman-Standard Div., Pullman Inc., Chicago; 25 covered hoppercars were also placed; total cost $4.8 million.

PLATES . . .

PLATES PLACED

250 tons, carbon, General Stores Supply Office, Navy, Philadelphia, to C. Itoh (America) Inc., New York.

PLATES PENDING

1675 tons, high tensile, Navy Purchasing Office, Washington, D. C.; bids Oct. 23.

235 tons, high tensile, Navy Purchasing Office, Washington; bids Oct. 19.

280 tons, 2.77-million-gallon water tank; Pittsburgh-DesMoines Steel Co., Seattle, low at $96,179 to Alderwood Manor, Wash.

215 tons, medium high tensile, grade M, Navy

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or less is the shipping time on most any type and gauge of standard Stainless Steel Strip from .0005 to .125, precision rolled and bright annealed and furnished **exactly as you want it.**

TWO MILLION

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Purchasing Office, Washington, D. C.; bids Oct. 26.

215 tons, carbon, Raritan Arsenal, Metuchen, N. J.; bids Nov. 3.

135 tons, General Stores Supply Office, Navy, Philadelphia; bids Nov. 5.

110 tons, carbon, Type 2, Brookley Air Force Base, Mobile, Ala.

Third Quarter Output of Steel Hits 21 Year Low

Production of steel in the third quarter was the smallest for any three month period since the third quarter of 1938, reports the American Iron & Steel Institute, but September output topped that of the preceding month.

Output was 8,201,406 tons vs. 33,790,135 tons in the preceding three months, 21,382,780 tons in the third quarter last year, and 8,193,218 tons in the third quarter, 1938.

September output of 1,535,000 tons compared with 1,439,277 in August and 7,632,372 tons in September, 1958.

The institute reported 72,479,609 tons were produced in the first nine months this year, up substantially from the 59,135,267 tons poured in the like period of 1958.

The index of steelmaking for September was 22.3 (in terms of average production during 1947-49). It compared with 20.2 in August and 110.9 in September a year ago. The index for the third quarter was 38.8 vs. 161.8 in the second quarter and 101.3 in the third quarter, 1958. The nine month index was 115.7 vs. 94.4 during the same period last year.

Based on the Jan. 1, 1959, capacity rating of 147,633,670 net tons, ingot operations averaged 12.7 per cent in September vs. 11.5 in August. The third quarter average was 22 per cent vs. 91.8 in the second quarter, while the nine months average was 65.6 per cent vs. 56.2 a year ago.

Steel Ingot Production—September, 1959

Period	OPEN HEARTH (Net tons)	BESSEMER (Net tons)	OXYGEN PROCESS (Net tons)	ELECTRIC (Net tons)	TOTAL (Net tons)	Per cent of capacity
1959						
January ...	8,280,985	120,005	186,820	729,575	9,317,385	74.3
February ..	8,541,031	128,515	176,970	756,422	9,602,938	84.8
March	10,216,474	184,892	236,595	929,784	11,567,745	92.3
1st Qtr. ...	27,038,490	433,412	600,385	2,415,781	30,488,068	83.8
April	9,884,322	195,730	237,018	964,850	11,281,920	93.0
May	10,117,968	200,887	257,325	1,024,401	11,600,581	92.5
June	9,521,053	185,794	259,731	941,056	10,907,634	89.9
2nd Qtr. ..	29,523,343	582,411	754,074	2,930,307	33,790,135	91.8
1st 6 Mo...	56,561,833	1,015,823	1,354,459	5,346,088	64,278,203	87.8
†July	4,540,182	66,433	94,489	526,025	5,227,129	41.7
*August ...	1,171,342	.....	.....	267,935	1,439,277	11.5
†September .	1,249,000	.....	.....	286,000	1,535,000	12.7
†3rd Qtr. ..	6,960,524	66,433	94,489	1,079,960	8,201,406	22.0
†9 Mo.	63,522,357	1,082,256	1,448,948	6,426,048	72,479,609	65.6

Period	—OPEN HEARTH— Net tons	Per cent of capacity	—BESSEMER— Net tons	Per cent of capacity	—ELECTRIC— Net tons	Per cent of capacity	—TOTAL— Net tons	Per cent of capacity
January ..	6,085,124	58.6	121,338	35.5	547,440	44.8	6,753,912	56.5
February .	5,252,112	56.0	81,597	26.4	448,614	40.6	5,782,323	53.6
March	5,598,944	53.9	122,317	35.8	533,361	43.6	6,254,622	52.3
1st Qtr. ..	16,936,180	56.2	325,252	32.8	1,529,425	43.1	18,790,857	54.1
April	4,875,619	48.5	109,433	33.1	547,939	46.3	5,532,991	47.8
May	5,602,123	53.9	110,366	32.3	588,670	48.2	6,301,159	52.7
June	6,378,942	63.4	88,125	26.6	660,413	55.8	7,127,480	61.6
2nd Qtr. ..	16,856,684	55.3	307,924	30.7	1,797,022	50.1	18,961,630	54.0
1st 6 Mo. .	33,792,864	55.7	633,176	31.7	3,326,447	46.6	37,752,487	54.1
July	5,712,587	55.0	114,218	33.4	615,600	50.4	6,442,405	53.9
August ...	6,481,185	62.4	134,435	39.3	692,383	56.6	7,308,003	61.1
September..	6,769,660	67.3	103,194	31.2	759,518	64.2	7,632,372	66.0
3rd Qtr. ..	18,963,432	61.5	351,847	34.7	2,067,501	57.0	21,382,780	60.3
9 Mo.	52,756,296	57.7	985,023	32.7	5,393,948	50.1	59,135,267	56.2
October ...	7,795,541	75.0	148,458	43.4	895,779	73.3	8,839,778	74.0
November..	7,572,555	75.3	145,867	44.1	850,896	71.9	8,596,318	74.1
December .	7,755,002	74.6	116,637	34.1	838,883	68.6	8,710,522	72.9
4th Qtr. ..	23,123,098	75.0	410,962	40.5	2,585,558	71.3	26,119,618	73.6
2nd 6 Mo..	42,086,530	68.3	762,809	37.6	4,653,059	64.1	47,502,398	67.0
Total	75,879,394	62.0	1,395,985	34.7	7,979,506	55.4	85,254,885	60.6

Note—The percentages are based on annual capacities as of Jan. 1, 1959: Open hearth, 126,528,380 net tons; bessemer, 3,577,000 net tons; basic oxygen process, 4,033,160 net tons; electric and crucible, 13,495,130 net tons. Total: 147,633,670 net tons. In 1958, the capacity tonnages were: Open hearth, 122,321,830 net tons; bessemer, 4,027,000 net tons; oxygen process, electric and crucible, 14,393,740 net tons. Total: 140,742,570 net tons.

*Revised. †Preliminary.

DISTRICT INGOT RATES

(Percentage of Capacity Engaged)

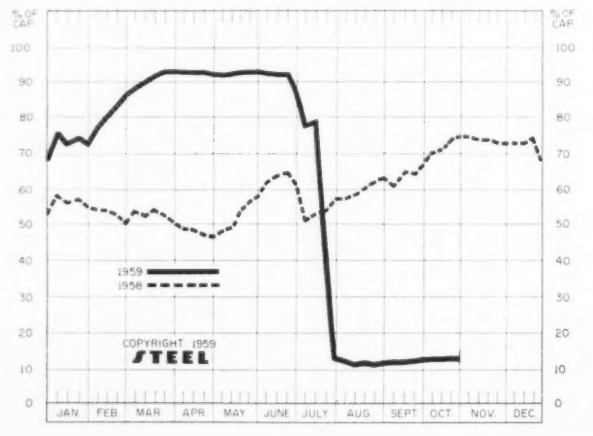
	Week Ended Oct. 25	Change	Same Week 1958	Same Week 1957
Pittsburgh	2	0	69	81
Chicago	5.5	0	85	83
Eastern	13	+ 2	71	81
Youngstown	9	0	64	65
Wheeling	56.5	+ 0.5	83	72.5
Cleveland	6	0	81.5	93.5
Buffalo	4	0	78	95
Birmingham	9	0	63.5	71.5
Cincinnati	74	+ 2*	81.5	85.5
St. Louis	64.5	+ 7.5*	95	90.5
Detroit	25	— 1*	83.5	98
Western	6	0	76	92
National Rate ..	13	0	75	79.5

INGOT PRODUCTION

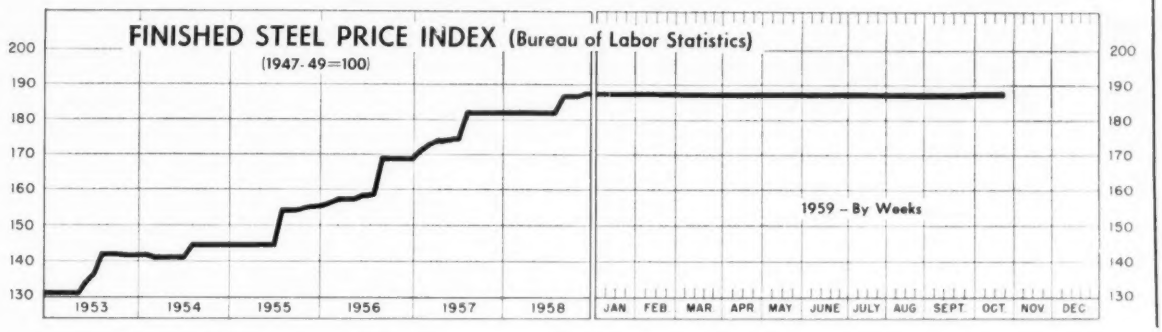
	Week Ended Oct. 25	Week Ago	Month Ago	Year Ago
INDEX ..... (1947-49=100)	22.9†	22.9	22.5	126.1
NET TONS .... (In thousands)	368†	368	362	2,026

*Change from preceding week's revised rate.
†Estimated by STEEL; comparative figures reported by AISI.
Weekly capacity (net tons): 2,831,331 in 1959; 2,699,173 in 1958; 2,559,490 in 1957.

NATIONAL STEELWORKS OPERATIONS



Price Indexes and Composites



Oct. 20, 1959	Week Ago	Month Ago	Oct. Index	Year Ago
186.8	**186.8**	**186.8**	**186.8**	**186.2**

AVERAGE PRICES OF STEEL (Bureau of Labor Statistics)

Week Ended Oct. 20

Prices include mill base prices and typical extras and deductions. Units are 100 lb except where otherwise noted in parentheses. For complete description of the following products and extras and deductions applicable to them, write to STEEL.

Rails, Standard No. 1	$5.825
Rails, Light, 40 lb	7.292
Tie Plates	6.875
Axles, Railway	10.175
Wheels, Freight Car, 33 in. (per wheel)	62.000
Plates, Carbon	6.350
Structural Shapes	6.167
Bars, Tool Steel, Carbon (lb)	0.560
Bars, Tool Steel, Alloy, Oil Hardening Die (lb)	0.680
Bars, Tool Steel, H.R. Alloy, High Speed, W 6.75, Cr 4.5, V 2.1, Mo 5.5, C 0.060 (lb)	1.400
Bars, Tool Steel, H.R. Alloy, High Speed, W18, Cr 4, V 1 (lb)	1.895
Bars, H.R., Alloy	10.775
Bars, H.R., Stainless, 303 (lb)	0.543
Bars, H.R., Carbon	6.675
Bars, Reinforcing	6.385
Bars, C.F., Carbon	10.710
Bars, C.F., Alloy	14.125
Bars, C.F., Stainless, 302 (lb)	0.570
Sheets, H.R., Carbon	6.350
Sheets, C.R., Carbon	7.300
Sheets, Galvanized	8.679
Sheets, C.R., Stainless, 302 (lb)	0.658
Sheets, Electrical	12.625
Strip, C.R., Carbon	9.489
Strip, C.R., Stainless, 430 (lb)	0.480
Strip, H.R., Carbon	6.250
Pipe, Black, Buttweld (100 ft)	19.905
Pipe, Galv., Buttweld (100 ft)	23.420
Pipe, Line (100 ft)	199.533
Casing, Oil Well, Carbon (100 ft)	201.080
Casing, Oil Well, Alloy (100 ft)	315.213
Tubes, Boiler (100 ft)	51.200
Tubing, Mechanical, Carbon (100 ft)	27.005
Tubing, Mechanical, Stainless, 304 (100 ft)	205.608
Tin Plate, Hot-dipped, 1.25 lb (95 lb base box)	10.100
Tin Plate, Electrolytic, 0.25 lb (95 lb base box)	8.800
Black Plate, Canmaking Quality (95 lb base box)	7.900
Wire, Drawn, Carbon	10.575
Wire, Drawn, Stainless, 430 (lb)	0.665
Bale Ties (bundles)	7.967
Nails, Wire, 8d Common	9.825
Wire, Barbed (80-rod spool)	8.742
Woven Wire Fence (20-rod roll)	21.765

STEEL's FINISHED STEEL PRICE INDEX*

	Oct. 21 1959	Week Ago	Month Ago	Year Ago	5 Yr Ago
Index (1935-39 avg=100)	247.82	247.82	247.82	246.65	194.53
Index in cents per lb	6.713	6.713	6.713	6.682	5.270

STEEL's ARITHMETICAL COMPOSITES*

Finished Steel, NT	$149.96	$149.96	$149.96	$149.28	$117.95
No. 2 Fdry, Pig Iron, GT.	66.49	66.49	66.49	66.49	56.54
Basic Pig Iron, GT	65.99	65.99	65.99	65.99	56.04
Malleable Pig Iron, GT	67.27	67.27	67.27	67.27	57.27
Steelmaking Scrap, GT	44.33	44.33	41.00	42.33	32.33

*For explanation of weighted index see STEEL, Sept. 19, 1949, p. 54; of arithmetical price composite, STEEL, Sept. 1, 1952, p. 130.

Comparison of Prices

Comparative prices by districts in cents per pound except as otherwise noted. Delivered prices based on nearest production point.

FINISHED STEEL	Oct. 21 1959	Week Ago	Month Ago	Year Ago	5 Yr Ago
Bars, H.R., Pittsburgh	5.675	5.675	5.675	5.675	4.30
Bars, H.R., Chicago	5.675	5.675	5.675	5.675	4.30
Bars, H.R., deld., Philadelphia	5.975	5.975	5.975	5.975	4.55
Bars, C.R., Pittsburgh	7.65*	7.65*	7.65*	7.65*	5.40
Shapes, Std., Pittsburgh	5.50	5.50	5.50	5.50	4.25
Shapes, Std., Chicago	5.50	5.50	5.50	5.50	4.25
Shapes, deld. Philadelphia	5.77	5.77	5.77	5.77	4.53
Plates, Pittsburgh	5.30	5.30	5.30	5.30	4.225
Plates, Chicago	5.30	5.30	5.30	5.30	4.225
Plates, Coatesville, Pa.	5.30	5.30	5.30	5.30	4.225
Plates, Sparrows Point, Md.	5.30	5.30	5.30	5.30	4.225
Plates, Claymont, Del.	5.30	5.30	5.30	5.30	4.225
Sheets, H.R., Pittsburgh	5.10	5.10	5.10	5.10	4.05
Sheets, H.R., Chicago	5.10	5.10	5.10	5.10	4.05
Sheets, C.R., Pittsburgh	6.275	6.275	6.275	6.275	4.95
Sheets, C.R., Chicago	6.275	6.275	6.275	6.275	4.95
Sheets, C.R., Detroit	6.275	6.275	6.275	6.275	5.10
Sheets, Galv., Pittsburgh	6.875	6.875	6.875	6.875	5.45
Strip, H.R., Pittsburgh	5.10	5.10	5.10	5.10	4.05
Strip, H.R., Chicago	5.10	5.10	5.10	5.10	4.05
Strip, C.R., Pittsburgh	7.425	7.425	7.425	7.425	5.75
Strip, C.R., Chicago	7.425	7.425	7.425	7.425	6.00
Strip, C.R., Detroit	7.425	7.425	7.425	7.425	5.60-5.90
Wire, Basic, Pittsburgh	8.00	8.00	8.00	8.00	5.75
Nails, Wire, Pittsburgh	8.95	8.95	8.95	8.95	6.85
Tin plate (1.50 lb)box,Pitts.	$10.65	$10.65	$10.65	$10.30	$9.05

*Including 0.35c for special quality.

SEMIFINISHED STEEL					
Billets, forging, Pitts. (NT)	$99.50	$99.50	$99.50	$99.50	$78.00
Wire rods $\frac{7}{32}$-$\frac{9}{32}$" Pitts.	6.40	6.40	6.40	6.40	4.675

PIG IRON, Gross Ton	Oct. 21 1959	Week Ago	Month Ago	Year Ago	5 Yr Ago
Bessemer, Pittsburgh	$67.00	$67.00	$67.00	$67.00	$57.00
Basic, Valley	66.00	66.00	66.00	66.00	56.00
Basic, deld., Philadelphia	70.41	70.41	70.41	70.41	59.66
No. 2 Fdry, NevilleIsland,Pa.	66.50	66.50	66.50	66.50	56.50
No. 2 Fdry, Chicago	66.50	66.50	66.50	66.50	56.50
No. 2 Fdry, deld., Phila.	70.91	70.91	70.91	70.91	50.16
No. 2 Fdry, Birmingham	62.50	62.50	62.50	62.50	52.88
No. 2 Fdry(Birm.)deld., Cin.	70.20	70.20	70.20	70.20	60.58
Malleable, Valley	66.50	66.50	66.50	66.50	56.50
Malleable, Chicago	66.50	66.50	66.50	66.50	56.50
Ferromanganese, net ton†	245.00	245.00	245.00	245.00	190.00

†74-76% Mn, Duquesne, Pa.

SCRAP, Gross Ton (Including broker's commission)					
No. 1 Heavy Melt, Pittsburgh	$44.50	$44.50	$41.50	$43.50	$32.50
No. 1 Heavy Melt, E. Pa.	45.00	45.00	41.00	41.00	31.50
No. 1 Heavy Melt, Chicago	43.50	43.50	40.50	42.50	33.00
No. 1 Heavy Melt, Valley	44.50	44.50	43.50	43.50	35.00
No. 1 Heavy Melt, Cleve.	41.50	41.50	39.50	40.00	32.00
No. 1 Heavy Melt, Buffalo	33.50	33.50	33.50	35.50	30.50
Rails, Rerolling, Chicago	64.50	64.50	62.50	62.00	56.00
No. 1 Cast, Chicago	57.50	57.50	55.50	45.50	39.50

COKE, Net Ton					
Beehive, Furn., Connlsvl.	$15.00	$15.00	$15.00	$15.25	$13.75
Beehive, Fdry., Connlsvl.	18.25	18.25	18.25	18.25	16.75
Oven, Fdry., Milwaukee	32.00	32.00	32.00	30.50	25.25

Steel Prices

Mill prices as reported to STEEL, Oct. 21, cents per pound except as otherwise noted. *Changes shown in italics.* Code number following mill point indicates producing company. Key to producers, page 243; footnotes, page 245.

SEMIFINISHED

INGOTS, Carbon, Forging (NT)
Munhall,Pa. U5 ..... $76.00

INGOTS, Alloy (NT)
Detroit S41 ..... $82.00
Economy,Pa. B14 ..... 82.00
Farrell,Pa. S3 ..... 82.00
Lowellville,O. S3 ..... 82.00
Midland,Pa. C18 ..... 82.00
Munhall,Pa. U5 ..... 82.00
Sharon,Pa. S3 ..... 82.00

BILLETS, BLOOMS & SLABS
Carbon, Rerolling (NT)
Bartonville,Ill. K4 ... $82.00
Bessemer,Pa. U5 ..... 80.00
Buffalo R2 ..... 80.00
Clairton,Pa. U5 ..... 80.00
Ensley,Ala. T2 ..... 80.00
Fairfield,Ala. T2 ..... 80.00
Fontana,Calif. K1 ..... 90.50
Gary,Ind. U5 ..... 80.00
Johnstown,Pa. B2 ..... 80.00
Lackawanna,N.Y. B2 .. 80.00
Munhall,Pa. U5 ..... 80.00
Owensboro,Ky. G8 ..... 80.00
S.Chicago,Ill. R2, U5 .. 80.00
S.Duquesne,Pa. U5 .. 80.00
Sterling,Ill. N15 ..... 80.00
Youngstown R2 ..... 80.00

Carbon, Forging (NT)
Bessemer,Pa. U5 ..... $99.50
Buffalo R2 ..... 99.50
Canton,O. R2 ..... 102.00
Clairton,Pa. U5 ..... 99.50
Conshohocken,Pa. A3 .. 104.50
Ensley,Ala. T2 ..... 99.50
Fairfield,Ala. T2 ..... 99.50
Farrell,Pa. S3 ..... 99.50
Fontana,Calif. K1 ... 109.00
Gary,Ind. U5 ..... 99.50
Geneva,Utah C11 ..... 99.50
Houston S5 ..... 104.50
Johnstown,Pa. B2 ..... 99.50
Lackawanna,N.Y. B2.. 99.50
LosAngeles B3 ..... 109.00
Midland,Pa. C18 ..... 99.50
Munhall,Pa. U5 ..... 99.50
Owensboro,Ky. G8 ..... 99.50
Seattle B3 ..... 109.00
Sharon,Pa. S3 ..... 99.50
S.Chicago R2, U5, W14 99.50
S.Duquesne,Pa. U5 ... 99.50
S.SanFrancisco B3 ... 109.00
Warren,O. C17 ..... 99.50

Alloy, Forging (NT)
Bethlehem,Pa. B2 .. $119.00
Bridgeport,Conn. C32.. 119.00
Buffalo R2 ..... 119.00
Canton,O. R2, T7 .... 119.00
Conshohocken,Pa. A3.. 128.00
Detroit S41 ..... 119.00
Economy,Pa. B14 .... 119.00
Farrell,Pa. S3 ..... 119.00
Fontana,Calif. K1 .... 140.00
Gary,Ind. U5 ..... 119.00
Houston S5 ..... 124.00
Ind.Harbor,Ind. Y1 .. 119.00
Johnstown,Pa. B2 .... 119.00
Lackawanna,N.Y. B2.. 119.00
LosAngeles B3 ..... 139.00
Lowellville,O. S3 .... 119.00
Massillon,O. R2 ..... 119.00
Midland,Pa. C18 ..... 119.00
Munhall,Pa. U5 ..... 119.00
Owensboro,Ky G8 .... 119.00
Sharon,Pa. S3 ..... 119.00
S.Chicago R2,U5,W14 119.00
S.Duquesne,Pa. U5 ... 119.00
Struthers,O. Y1 ..... 119.00
Warren,O. C17 ..... 119.00

ROUNDS, SEAMLESS TUBE (NT)
Buffalo R2 ..... $122.50
Canton,O. R2 ..... 125.00
Cleveland R2 ..... 122.50
Gary,Ind. U5 ..... 122.50
S.Chicago,Ill. R2, W14 122.50
S.Duquesne,Pa. U5 .. 122.50
Warren,O. C17 ..... 122.50

SKELP
Aliquippa,Pa. J5 ..... 5.05
Munhall,Pa. U5 ..... 5.05
Pittsburgh J5 ..... 5.05
Warren,O. R2 ..... 5.05
Youngstown R2, U5 .... 5.05

WIRE RODS
AlabamaCity,Ala. R2 .. 6.40
Aliquippa,Pa. J5 ..... 6.40
Alton,Ill. L1 ..... 6.60
Bartonville,Ill. K4 ..... 6.50
Buffalo W12 ..... 6.40
Cleveland A7 ..... 6.40
Donora,Pa. A7 ..... 6.40
Fairfield,Ala. T2 ..... 6.40
Houston S5 ..... 6.65
IndianaHarbor,Ind. Y1 .. 6.40
Johnstown,Pa. B2 ..... 6.40
Joliet,Ill. A7 ..... 6.40
KansasCity,Mo. S5 .... 6.65
Kokomo,Ind. C16 ..... 6.50
LosAngeles B3 ..... 7.20
Minnequa,Colo. C10 .... 6.65
Monessen,Pa. P7 ..... 6.40
Pittsburg,Calif. C11 .... 7.20
Portsmouth,O. P12 .... 6.40
Roebling,N.J. R5 ..... 6.50
S.Chicago,Ill. R2, W14.. 6.40
SparrowsPoint,Md. B2.. 6.50
Sterling,Ill.(1) N15 .... 6.40
Sterling,Ill. N15 ..... 6.50
Struthers,O. Y1 ..... 6.40
Worcester,Mass. A7 .... 6.70

STRUCTURALS

Carbon Steel Std. Shapes
AlabamaCity,Ala. R2 .. 5.50
Aliquippa,Pa. J5 ..... 5.50
Atlanta A11 ..... 5.70
Bessemer, Ala. T2 .... 5.50
Bethlehem,Pa. B2 ..... 5.55
Birmingham C15 ..... 5.50
Clairton,Pa. U5 ..... 5.50
Fairfield,Ala. T2 ..... 5.50
Fontana,Calif. K1 ..... 6.30
Gary,Ind. U5 ..... 5.50
Geneva,Utah C11 ..... 5.50
Houston S5 ..... 5.60
Ind.Harbor,Ind. I-2, Y1 .. 5.50
Johnstown,Pa. B2 ..... 5.55
Joliet,Ill. P22 ..... 5.50
KansasCity,Mo. S5 .... 5.60
Lackawanna,N.Y. B2 .. 5.55
LosAngeles B3 ..... 6.20
Minnequa,Colo. C10 .... 5.80
Munhall,Pa. U5 ..... 5.50
Niles,Calif. P1 ..... 6.25
Phoenixville,Pa. P4 .... 5.55
Portland,Oreg. O4 ..... 6.25
Seattle B3 ..... 6.25
S.Chicago,Ill. U5, W14 .. 5.50
S.SanFrancisco B3 .... 6.15
Sterling,Ill. N15 ..... 5.50
Torrance,Calif. C11 .... 6.20
Weirton,W.Va. W6 .... 5.50

Wide Flange
Bethlehem,Pa. B2 ..... 5.55
Clairton,Pa. U5 ..... 5.50
Fontana,Calif. K1 ..... 6.45
IndianaHarbor,Ind. I-2 .. 5.50
Lackawanna,N.Y. B2 .. 5.55
Munhall,Pa. U5 ..... 5.50
Phoenixville,Pa. P4 .... 5.55
S.Chicago,Ill. U5 .... 5.50
Sterling,Ill. N15 ..... 5.50
Weirton,W.Va. W16 .... 5.50

Alloy Std. Shapes
Aliquippa,Pa. J5 ..... 6.80
Clairton,Pa. U5 ..... 6.80
Gary,Ind. U5 ..... 6.80
Houston S5 ..... 6.90
Munhall,Pa. U5 ..... 6.80
S.Chicago,Ill. U5, W14.. 6.80

H.S., L.A., Std. Shapes
Aliquippa,Pa. J5 ..... 8.05
Bessemer,Ala. T2 ..... 8.05
Bethlehem,Pa. B2 ..... 8.10
Clairton,Pa. U5 ..... 8.05
Fairfield,Ala. T2 ..... 8.05
Fontana,Calif. K1 .... 8.85
Gary,Ind. U5 ..... 8.05
Geneva,Utah C11 ..... 8.05
Houston S5 ..... 8.15
Ind.Harbor,Ind. I-2, Y1 .. 8.05
Johnstown,Pa. B2 .... 8.10
KansasCity,Mo. S5 .... 8.15
Lackawanna,N.Y. B2 .. 8.10
LosAngeles B3 ..... 8.75
Munhall,Pa. U5 ..... 8.05
Seattle B3 ..... 8.80
S.Chicago,Ill. U5, W14.. 8.05
S.SanFrancisco B3 .... 8.70
Sterling,Ill. N15 ..... 7.75
Struthers,O. Y1 ..... 8.05

H.S., L.A., Wide Flange
Bethlehem,Pa. B2 ..... 8.10
Ind.Harbor,Ind. I-2 .... 8.05
Lackawanna,N.Y. B2 .. 8.10
Munhall,Pa. U5 ..... 8.05
S.Chicago,Ill. U5 ..... 8.05
Sterling,Ill. N15 ..... 7.75

PILING

BEARING PILES
Bethlehem,Pa. B2 ..... 5.55
Ind.Harbor,Ind. I-2 ..... 5.50
Lackawanna,N.Y. B2 .. 5.55
Munhall,Pa. U5 ..... 5.50
S.Chicago,Ill. I-2, U5 .. 5.50

STEEL SHEET PILING
Ind.Harbor,Ind. I-2 .... 6.50
Lackawanna,N.Y. B2 .. 6.50
Munhall,Pa. U5 ..... 6.50
S.Chicago,Ill. I-2, U5 .. 6.50
Weirton,W.Va. W6 .... 6.50

PLATES

PLATES, Carbon Steel
AlabamaCity,Ala. R2 .. 5.30
Aliquippa,Pa. J5 ..... 5.30
Ashland,Ky.(15) A10 .. 5.30
Atlanta A11 ..... 5.50
Bessemer,Ala. T2 ..... 5.30
Clairton,Pa. U5 ..... 5.30
Claymont,Del. C22 ..... 5.30
Cleveland J5, R2 ..... 5.30
Coatesville,Pa. L7 .... 5.30
Conshohocken,Pa. A3 .. 5.30
Ecorse,Mich. G5 ..... 5.30
Fairfield,Ala. T2 ..... 5.30
Farrell,Pa. S3 ..... 5.30
Fontana,Calif.(30) K1 .. 6.10
Gary,Ind. U5 ..... 5.30
Geneva,Utah C11 ..... 5.30
GraniteCity,Ill. G4 .... 5.40
Harrisburg,Pa. P4 ..... 5.30
Houston S5 ..... 5.40
Ind.Harbor,Ind. I-2, Y1 5.30
Johnstown,Pa. B2 ..... 5.30
Lackawanna,N.Y. B2 .. 5.30
Mansfield O. E6 ..... 5.30
Minnequa,Colo. C10 .... 6.15
Munhall,Pa. U5 ..... 5.30
Newport,Ky. A2 ..... 5.30
Pittsburgh J5 ..... 5.30
Riverdale,Ill. A1 ..... 5.30
Seattle B3 ..... 6.20
Sharon,Pa. S3 ..... 5.30
S.Chicago,Ill. U5, W14.. 5.30
SparrowsPoint,Md. B2.. 5.30
Sterling,Ill. N15 ..... 5.30
Steubenville,O. W10 .... 5.30
Warren,O. R2 ..... 5.30
Youngstown U5, Y1 .... 5.30
Youngstown(27) R2 ... 5.30

PLATES, Carbon Abras. Resist.
Claymont,Del. C22 .... 7.05
Fontana,Calif. K1 ..... 7.85
Geneva,Utah C11 ..... 7.05
Houston S5 ..... 7.15
Johnstown,Pa. B2 ..... 7.05
SparrowsPoint,Md. B2 .. 7.05

PLATES, Wrought Iron
Economy,Pa. B14 .... 13.55

PLATES, H.S., L.A.
Aliquippa,Pa. J5 ..... 7.95
Ashland,Ky. A10 ..... 7.95
Bessemer,Ala. T2 ..... 7.95
Clairton,Pa. U5 ..... 7.95
Claymont,Del. C22 .... 7.95
Cleveland J5, R2 ..... 7.95
Coatesville,Pa. L7 .... 7.95
Conshohocken,Pa. A3 .. 7.95
Economy,Pa. B14 ..... 7.95
Ecorse,Mich. G5 ..... 7.95
Fairfield,Ala. T2 ..... 7.95
Farrell,Pa. S3 ..... 7.95
Fontana,Calif.(30) K1 .. 8.75
Gary,Ind. U5 ..... 7.95
Geneva,Utah C11 ..... 7.95
Houston S5 ..... 8.05
Ind.Harbor,Ind. I-2, Y1.. 7.95
Johnstown,Pa. B2 ..... 7.95
Munhall,Pa. U5 ..... 7.95
Pittsburgh J5 ..... 7.95
Seattle B3 ..... 8.85
Sharon,Pa. S3 ..... 7.95
S.Chicago,Ill. U5, W14.. 7.95
SparrowsPoint,Md. B2.. 7.95
Warren,O. R2 ..... 7.95
Youngstown U5, Y1 .... 7.95

PLATES, Alloy
Aliquippa,Pa. J5 ..... 7.50
Claymont,Del. C22 .... 7.50
Coatesville,Pa. L7 .... 7.50
Economy,Pa. B14 ..... 7.50
Farrell,Pa. S3 ..... 7.50
Fontana,Calif. K1 .... 8.30
Gary,Ind. U5 ..... 7.50
Houston S5 ..... 7.60
Ind.Harbor,Ind. Y1 .... 7.50
Johnstown,Pa. B2 .... 7.50
Lowellville,O. S3 ..... 7.50
Munhall,Pa. U5 ..... 7.50
Newport,Ky. A2 ..... 7.50
Pittsburgh J5 ..... 7.50
Seattle B3 ..... 8.40
Sharon,Pa. S3 ..... 7.50
S.Chicago,Ill. U5, W14.. 7.50
SparrowsPoint,Md. B2.. 7.50
Youngstown Y1 ..... 7.50

FLOOR PLATES
Cleveland J5 ..... 6.375
Conshohocken,Pa. A3 .. 6.375
Ind.Harbor,Ind. I-2 .. 6.375
Munhall,Pa. U5 ..... 6.375
Pittsburgh J5 ..... 6.375
S.Chicago,Ill. U5 ..... 6.375

PLATES, Ingot Iron
Ashland c.l. (15) A10 .. 5.55
Ashland l.c.l. (15) A10 .. 6.05
Cleveland c.l. R2 ..... 6.05
Warren,O. c.l. R2 .... 6.05

BARS

BARS, Hot-Rolled Carbon (Merchant Quality)
Ala.City,Ala.(9) R2 .. 5.675
Aliquippa,Pa.(9) J5 .. 5.675
Alton,Ill. L1 ..... 5.875
Atlanta(9) A11 ..... 5.875
Bessemer,Ala.(9) T2 .. 5.675
Birmingham(9) C15 .. 5.675
Buffalo(9) R2 ..... 5.675
Canton,O.(23) R2 ..... 6.15
Clairton,Pa. (9) U5 .. 5.675
Cleveland(9) R2 ..... 5.675
Ecorse,Mich.(9) G5 .. 5.675
Emeryville,Calif. J7 .. 6.425
Fairfield,Ala.(9) T2 .. 5.675
Fairless,Pa.(9) U5 .... 5.825
Fontana,Calif.(9) K1 .. 6.375
Gary,Ind.(9) U5 ..... 5.675
Houston(9) S5 ..... 5.925
Ind.Harbor(9) I-2, Y1 5.675
Johnstown,Pa.(9) B2 .. 5.675
Joliet,Ill. P22 ..... 5.675
KansasCity,Mo.(9) S5 .. 5.925
Lackawanna(9) B2 .... 5.675
LosAngeles(9) B3 .... 6.375
Massillon,O.(23) R2 ... 6.15
Midland,Pa.(23) C18 .. 6.025
Milton,Pa. M18 ..... 5.825
Minnequa,Colo. C10 .. 6.125
Niles,Calif. P1 ..... 6.375
Owensboro,Ky.(9) G8 .. 6.025
Pittsburg,Calif.(9) C11 .. 6.375
Pittsburgh(9) J5 .... 5.675
Portland,Oreg. O4 .... 6.425
Riverdale,Ill.(9) A1 .. 5.675
Seattle A24, B3, N14.. 6.425
S.Ch'e'go(9)R2,U5,W14 5.675
S.Duquesne,Pa.(9) U5.. 5.675
S.SanFran.,Calif.(9)B3 6.425
Sterling,Ill.(1)(9) N15.. 5.675
Sterling,Ill.(9) N15 .. 5.775
Struthers,O.(9) Y1 .... 5.675
Tonawanda,N.Y. B12.. 5.675
Torrance Calif.(9) C11.. 6.375
Warren,O. C17 ..... 6.025
Youngstown(9) R2, U5.. 5.675

BARS, Hot-Rolled Alloy
Aliquippa,Pa. J5 ..... 6.725
Bethlehem,Pa. B2 .... 6.725
Bridgeport,Conn. C32 .. 6.80
Buffalo R2 ..... 6.725
Canton,O. R2, T7 .... 6.725
Clairton,Pa. U5 ..... 6.275
Detroit S41 ..... 6.725
Economy,Pa. B14 .... 6.725
Ecorse,Mich. G5 ..... 6.725
Fairless,Pa. U5 ..... 6.875
Farrell,Pa. S3 ..... 6.725
Fontana,Calif. K1 .... 7.775
Gary,Ind. U5 ..... 6.725
Houston S5 ..... 6.975
Ind.Harbor,Ind. I-2, Y1.. 6.725
Johnstown,Pa. B2 .... 6.725
KansasCity,Mo. S5 .... 6.975
Lackawanna,N.Y. B2 .. 6.725
LosAngeles B3 ..... 7.775
Lowellville,O. S3 ..... 6.725
Massillon,O. R2 ..... 6.725
Midland,Pa. C18 ..... 6.725
Owensboro,Ky. G8 .... 6.725
Pittsburgh J5 ..... 6.725
Sharon,Pa. S3 ..... 6.725
S.Chicago R2, U5, W14 6.725
S.Duquesne,Pa. U5 .... 6.725
Struthers,O. Y1 ..... 6.725
Warren,O. C17 ..... 6.725
Youngstown U5 ..... 6.725

BARS & SMALL SHAPES, H.R. High-Strength, Low-Alloy
Aliquippa,Pa. J5 ..... 8.30
Bessemer,Ala. T2 ..... 8.30
Bethlehem,Pa. B2 ..... 8.30
Clairton,Pa. U5 ..... 8.30
Cleveland R2 ..... 8.30
Ecorse,Mich. G5 ..... 8.30
Fairfield,Ala. T2 ..... 8.30
Fontana,Calif. K1 .... 9.00
Gary,Ind. U5 ..... 8.30
Houston S5 ..... 8.55
Ind.Harbor,Ind. Y1 .... 8.30
Johnstown,Pa. B2 .... 8.30
KansasCity,Mo. S5 .... 8.55
Lackawanna,N.Y. R2 .. 8.30
LosAngeles B3 ..... 9.00
Pittsburgh J5 ..... 8.30
Seattle B3 ..... 9.05
S.Chicago,Ill. R2, W14 8.30
S.Duquesne,Pa. U5 .... 8.30
S.SanFrancisco B3 .... 9.05
Struthers,O. Y1 ..... 8.30
Youngstown U5 ..... 8.30

BAR SIZE ANGLES; H.R. Carbon
Bethlehem,Pa.(9) B2 .. 5.825
Houston(9) S5 ..... 5.925
KansasCity,Mo.(9)S5 .. 5.925
Lackawanna(9) B2 .... 5.675
Sterling,Ill. N15 ..... 5.775
Sterling,Ill.(1) N15 ... 5.675
Tonawanda,N.Y. B12 .. 5.675

BAR SIZE ANGLES; S. Shapes
Aliquippa,Pa. J5 ..... 5.675
Atlanta A11 ..... 5.875
Joliet,Ill. P22 ..... 5.675
Minnequa,Colo. C10 .. 6.125
Niles,Calif. P1 ..... 6.375
Pittsburgh J5 ..... 5.675
Portland,Oreg. O4 .... 6.425
Seattle B3 ..... 6.425

BAR SHAPES, Hot-Rolled Alloy
Aliquippa,Pa. J5 ..... 6.80
Clairton,Pa. U5 ..... 6.80
Gary,Ind. U5 ..... 6.80
Houston S5 ..... 7.05
KansasCity,Mo. S5 .... 7.05
Pittsburgh J5 ..... 6.80
Youngstown U5 ..... 6.80

BARS, C.F. Loaded (Including loaded extra)
Carbon
LosAngeles P2, S30 .. 11.75*

Alloy
Ambridge,Pa. W18 .. 10.175
BeaverFalls,Pa. M12.. 10.175
Camden,N.J. P13 .... 10.35
Chicago W18 ..... 10.175
Elyria,O. W8 ..... 10.175
Monaca,Pa. S17 ..... 10.175
Newark,N.J. W18 .... 10.35
SpringCity,Pa. K3 .... 10.35

*Grade A; add 0.05c for Grade B.

BARS, Cold-Finished Carbon
Ambridge,Pa. W18 .... 7.65
BeaverFalls,Pa. M12,R2. 7.65
Birmingham C15 ..... 8.25
Buffalo B5 ..... 7.70
Camden,N.J. P13 ..... 8.10
Carnegie,Pa. C12 ..... 7.65
Chicago W18 ..... 7.65
Cleveland A7, C20 .... 7.65
Detroit B5, P17 ..... 7.85
Detroit S41 ..... 7.65
Donora,Pa. A7 ..... 7.65
Elyria,O. W8 ..... 7.65
FranklinPark,Ill. N5 .. 7.65
Gary,Ind. R2 ..... 7.65
GreenBay,Wis. F7 ..... 7.65
Hammond,Ind. J5, L2 7.65
Hartford,Conn. R2 .... 8.15
Harvey,Ill. B5 ..... 7.65
LosAngeles(49) S30 .... 9.10
LosAngeles(49) P2, R2 9.10
Mansfield,Mass. B5 .... 8.20
Massillon,O. R2, R8 .. 7.65
Midland,Pa. C18 ..... 7.65
Monaca,Pa. S17 ..... 7.65
Newark,N.J. W18 ..... 8.10
NewCastle,Pa.(17) B4 .. 7.65
Pittsburgh J5 ..... 7.65
Plymouth,Mich. P5 .... 7.90
Putnam,Conn. W18 .... 8.20
Readville,Mass. C14 .... 8.20
S.Chicago,Ill. W14 .... 7.65
SpringCity,Pa. K3 .... 8.10
Struthers,O. Y1 ..... 7.65
Warren,O. C17 ..... 7.65
Waukegan,Ill. A7 ..... 7.65
Willimantic,Conn. J5 .. 8.15
Youngstown F3, Y1 ... 7.65

BARS, Cold-Finished Carbon (Turned and Ground)
Cumberland,Md.(5; C19.6.55

BARS, Cold-Finished Alloy
Ambridge,Pa. W18 .... 9.025
BeaverFalls,Pa.M12,R2 9.025
Bethlehem,Pa. B2 .... 9.025
Bridgeport,Conn. C32 .. 9.175
Buffalo B5 ..... 9.025
Camden,N.J. P13 ..... 9.20
Canton,O. T7 ..... 9.025
Carnegie,Pa. C12 .... 9.025
Chicago W18 ..... 9.025
Cleveland A7, C20 .... 9.025
Detroit B5, P17 ..... 9.225
Detroit S41 ..... 9.025
Donora,Pa. A7 ..... 9.025
Elyria,O. W8 ..... 9.025
FranklinPark,Ill. N5 .. 9.025
Gary,Ind. R2 ..... 9.025
GreenBay,Wis. F7 .... 9.025
Hammond,Ind. J5, L2.. 9.025
Hartford,Conn. R2 .... 9.325
Harvey,Ill. R5 ..... 9.025
Lackawanna,N.Y. B2.. 9.025
LosAngeles P2, S30 .... 11.00
Mansfield,Mass. B5 .... 9.325
Massillon,O. R2, R8 .... 9.025
Midland,Pa. C18 ..... 9.025
Monaca,Pa. S17 ..... 9.025
Newark,N.J. W18 ..... 9.20
Plymouth,Mich. P5 .... 9.225
S.Chicago,Ill. W14 .... 9.025
SpringCity,Pa. K3 ..... 9.20
Struthers,O. Y1 ..... 9.025
Warren,O. C17 ..... 9.025
Waukegan,Ill. A7 ..... 9.025
Willimantic,Conn. J5 .. 9.325
Worcester,Mass. A7 .. 9.325
Youngstown F3, Y1 ... 9.025

BARS, Reinforcing, Billet (To Fabricators)

AlabamaCity,Ala. R2 ..5.675
Atlanta A11 .....5.675
Birmingham C15 .....5.675
Buffalo R2 .....5.675
Cleveland R2 .....5.675
Ecorse,Mich. G5 .....5.675
Emeryville,Calif. J7 ...6.425
Fairfield,Ala. T2 .....5.675
Fairless,Pa. U5 .....5.825
Fontana,Calif. K1 ....6.375
Ft.Worth,Tex(4)(26)T4..5.925
Gary,Ind. U5 .....5.675
Houston S5 .....5.925
Ind.Harbor,Ind. I-2, Y1 5.675
Johnstown,Pa. B2 .....5.675
Joliet,Ill. P22 .....5.675
KansasCity,Mo. S5 ....5.925
Kokomo,Ind. C16 .....5.775
Lackawanna N.Y. B2 ..5.675
LosAngeles B3 .....6.375
Madison,Ill. L1 .....5.875
Milton,Pa. M18 .....5.825
Minnequa,Colo. C10 ...6.125
Niles,Calif. P1 .....6.375
Pittsburg,Calif. C11 ..6.375
Pittsburgh J5 .....5.675
Portland,Oreg. O4 ....6.425
SandSprings,Okla. S5 ..5.925
Seattle A24, B3, N14 ..6.425
S.Chicago,Ill. R2, W14.5.675
S.Duquesne,Pa. U5 ....5.675
S.SanFrancisco B3 ....6.425
SparrowsPoint,Md. B2..5.675
Sterling,Ill.(1) N15 ...5.675
Sterling,Ill. N15 .....5.775
Struthers,O. Y1 .....5.675
Tonawanda N.Y. B12 ..6.10
Torrance,Calif. C11 ...6.375
Youngstown R2, U5 ..5.675

BARS, Reinforcing, Billet (Fabricated: To Consumers)

Baltimore B2 .....7.42
Boston B2, U8 .....8.15
Chicago U8 .....7.41
Cleveland U8 .....7.39
Houston S5 .....7.60
Johnstown,Pa. B2 .....7.33
KansasCity,Mo. S5 .....7.60
Lackawanna,N.Y. B2 ..7.35
Marion,O. P11 .....6.70
Newark,N.J. U8 .....7.80
Philadelphia U8 .....7.63
Pittsburgh J5, U8 .....7.35
SandSprings,Okla. S5 ..7.60
Seattle A24, B3, N14 ..7.95
SparrowsPt.,Md. B2 ...7.33
St.Paul U8 .....8.17
Williamsport,Pa. S19 ...7.25

BARS, Wrought Iron

Economy,Pa.(S.R.)B14 14.90
Economy,Pa.(D.R.)B14 18.55
Economy(Staybolt)B14 19.60
McK.Rks.(S.R.) L5 .. 14.50
McK.Rks.(D.R.) L5 ...19.80
McK.Rks.(Staybolt)L5, 20.95

BARS, Rail Steel

ChicagoHts.(3) C2, I-2.5.575
ChicagoHts.(4)(44) I-2.5.675
ChicagoHts.(4) C2 ....5.675
Franklin,Pa.(3) F5 ...5.575
Franklin,Pa.(4) F5 ...5.675
JerseyShore,Pa.(3) J8 ..5.55
Marion,O.(3) P11 .....5.575
Tonawanda(3) B12 ...5.575
Tonawanda(4) B12 ....6.10

SHEETS

SHEETS, Hot-Rolled Steel (18 Gage and Heavier)

AlabamaCity,Ala. R2 ..5.10
Allenport,Pa. P7 .....5.10
Aliquippa,Pa. J5 .....5.10
Ashland,Ky.(8) A10 ...5.10
Cleveland J5, R2 .....5.10
Conshohocken,Pa. A3 ..5.15
Detroit(8) M1 .....5.10
Ecorse,Mich. G5 .....5.10
Fairfield,Ala. T2 .....5.10
Fairless,Pa. U5 .....5.15
Farrell,Pa. S3 .....5.10
Fontana,Calif. K1 ....5.825
Gary,Ind. U5 .....5.10
Geneva Utah C11 .....5.20
GraniteCity,Ill.(8) G4 ..5.20
Ind.Harbor,Ind. I-2, Y1.5.10
Irvin,Pa. U5 .....5.10
Lackawanna,N.Y. B2 ..5.10
Mansfield,O. E6 .....5.10
Munhall,Pa. U5 .....5.10
Newport,Ky. A2 .....5.10
Niles O. M21, S3 .....5.10
Pittsburg,Calif. C11 ....5.80
Pittsburgh J5 .....5.10
Portsmouth,O. P12 .....5.10
Riverdale,Ill. A1 .....5.10
Sharon,Pa. S3 .....5.10
S.Chicago,Ill. U5, W14..5.10
SparrowsPoint,Md. B2 ..5.10
Steubenville,O. W10 ....5.10
Warren,O. R2 .....5.10
Weirton,W.Va. W6 ....5.10
Youngstown U5, Y1 ....5.10

SHEETS, H.R. (19 Ga. & Lighter)

Niles,O. M21, S3 .....6.275

SHEETS, H.R., Alloy

Gary,Ind. U5 .....8.40
Ind.Harbor,Ind. Y1 ....8.40
Irvin,Pa. U5 .....8.40
Munhall,Pa. U5 .....8.40
Newport,Ky. A2 .....8.40
Youngstown U5, Y1 ....8.40

SHEETS, H.R. (14 Ga. & Heavier) High-Strength, Low-Alloy

Aliquippa,Pa. J5 .....7.525
Ashland,Ky. A10 .....7.525
Cleveland J5, R2 .....7.525
Conshohocken,Pa. A3 ..7.575
Ecorse,Mich. G5 .....7.525
Fairfield,Ala. T2 .....7.525
Fairless,Pa. U5 .....7.575
Farrell,Pa. S3 .....7.525
Fontana,Calif. K1 .....8.25
Gary,Ind. U5 .....7.525
Ind.Harbor,Ind. I-2, Y1 7.525
Irvin,Pa. U5 .....7.525
Lackawanna(35) B2 ...7.525
Munhall,Pa. U5 .....7.525
Niles,O. S3 .....7.525
Pittsburgh J5 .....7.525
S.Chicago,Ill. U5, W14.7.525
Sharon,Pa. S3 .....7.525
SparrowsPoint(36) B2..7.525
Warren,O. R2 .....7.525
Weirton,W.Va. W6 ....7.525
Youngstown U5, Y1 ...7.525

SHEETS, Hot-Rolled Ingot Iron (18 Gage and Heavier)

Ashland Ky.(8) A10 ...5.35
Cleveland R2 .....5.875
Warren,O. R2 .....5.875

SHEETS, Cold-Rolled Ingot Iron

Cleveland R2 .....7.05
Middletown,O. A10 ....6.775
Warren,O. R2 .....7.05

SHEETS, Cold-Rolled Steel (Commercial Quality)

AlabamaCity,Ala. R2 .6.275
Aliquippa,Pa. J5 .....6.275
Allenport,Pa. P7 .....6.275
Cleveland J5, R2 .....6.275
Conshohocken,Pa. A3 ..6.325
Detroit M1 .....6.275
Ecorse,Mich. G5 .....6.275
Fairfield,Ala. T2 .....6.275
Fairless,Pa. U5 .....6.325
Follansbee,W.Va. F4 ..6.275
Fontana,Calif. K1 ....7.40
Gary,Ind. U5 .....6.275
GraniteCity,Ill. G4 ....6.375
Ind.Harbor,Ind. I-2, Y1 6.275
Irvin,Pa. U5 .....6.275
Lackawanna,N.Y. B2 ..6.275
Mansfield,O. E6 .....6.275
Middletown,O. A10 ....6.275
Newport,Ky. A2 .....6.275
Pittsburg,Calif. C11 ...7.225
Pittsburgh J5 .....6.275
Portsmouth,O. P12 ....6.275
SparrowsPoint,Md. B2 .6.275
Steubenville,O. W10 ...6.275
Warren,O. R2 .....6.275
Weirton,W.Va. W6 ....6.275
Yorkville,O. W10 .....6.275
Youngstown Y1 .....6.275

SHEETS, Cold-Rolled, High-Strength, Low-Alloy

Aliquippa,Pa. J5 .....9.275
Cleveland J5, R2 .....9.275
Ecorse,Mich. G5 .....9.275
Fairless,Pa. U5 .....9.325
Fontana,Calif. K1 ....10.40
Gary,Ind. U5 .....9.275
Ind.Harbor,Ind. I-2, Y1 9.275
Lackawanna(37) B2 ..9.275
Pittsburgh J5 .....9.275
SparrowsPoint(38) B2..9.275
Warren,O. R2 .....9.275
Weirton,W.Va. W6 ....9.275
Youngstown Y1 .....9.275

SHEETS, Culvert

	Cu Steel	Cu Fe
Ala.City,Ala. R2	7.225	....
Ashland,Ky. A10	7.225	7.475
Canton,O. R2	7.225	7.75
Fairfield,Ala. T2	7.225	7.475
Gary,Ind. U5	7.225	7.475
GraniteCity,Ill.G4	7.325	....
Ind.Harbor I-2	7.225	7.475
Irvin,Pa. U5	7.225	7.475
Kokomo,Ind. C16	7.325	....
MartinsFry. W10	7.225	7.475
Pitts.,Calif. C11	7.975	....
Pittsburgh J5	7.225	....
SparrowsPt. B2	7.225	....

SHEETS, Culvert—Pure Iron

Ind.Harbor,Ind. I-2 ....7.475

SHEETS, Galvanized Steel Hot-Dipped

AlabamaCity,Ala. R2 .6.875‡
Ashland,Ky. A10 ....6.875‡
Canton,O. R2 .....6.875‡
Dover,O. E6 .....6.875†
Fairfield,Ala. T2 ....6.875†
Gary,Ind. U5 .....6.875†
GraniteCity,Ill. G4 ....6.975*
Ind.Harbor,Ind. I-2 ..6.875†
Irvin,Pa. U5 .....6.875†
Kokomo,Ind. C16 ....6.975‡
MartinsFerry,O. W10..6.875*
Middletown,O. A10 ..6.875†
Pittsburg,Calif. C11 ...7.625*
Pittsburgh J5 .....6.875†
SparrowsPt.,Md. B2 ..6.875†
Warren,O. R2 .....6.875†
Weirton,W.Va. W6 ...6.875*

*Continuous and noncontinuous. †Continuous. ‡Noncontinuous.

SHEETS, Well Casing

Youngstown Y1 .....7.325

SHEETS, Galvanized High-Strength, Low-Alloy

Irvin,Pa. U5 .....10.125
Pittsburgh J5 .....10.125
SparrowsPt.(39) B2 ..10.025

SHEETS, Galvannealed Steel

Canton,O. R2 .....7.275
Irvin,Pa. U5 .....7.275

SHEETS, Galvanized Ingot Iron (Hot-Dipped Continuous)

Ashland,Ky. A10 .....7.125
Middletown,O. A10 ....7.125

SHEETS, Electrogalvanized

Cleveland(28) R2 .....7.65
Niles,O.(28) R2 .....7.65
Weirton,W.Va. W6 .....7.50
Youngstown J5 .....7.50

SHEETS, Aluminum Coated

Butler,Pa. A10 (type 1) 9.525
Butler,Pa. A10 (type 2) 9.625

SHEETS, Enameling Iron

Ashland,Ky. A10 .....6.775
Cleveland R2 .....6.775
Fairfield,Ala. T2 .....6.775
Gary,Ind. U5 .....6.775
Ind.Harbor,Ind. I-2, Y1 6.775
Irvin,Pa. U5 .....6.775
Middletown,O. A10 ....6.775
Niles,O. M21, S3 .....6.775
Youngstown Y1 .....6.775

BLUED STOCK, 29 Gage

Dover,O. E6 .....8.70
Follansbee,W.Va. F4 ...8.70
Ind.Harbor,Ind. I-2 ....8.70
Mansfield,O. E6 .....8.70
Warren,O. R2 .....8.70
Yorkville,O. W10 .....8.70

SHEETS, Long Terne, Steel (Commercial Quality)

BeechBottom,W.Va.W10 7.225
Gary,Ind. U5 .....7.225
Mansfield,O. E6 .....7.225
Middletown,O. A10 ....7.225
Niles,O. M21, S3 .....7.225
Warren,O. R2 .....7.225
Weirton,W.Va. W6 ....7.225

SHEETS, Long Terne, Ingot Iron

Middletown,O. A10 ....7.625

Key to Producers

A1 Acme Steel Co.
A2 Acme-Newport Steel Co.
A3 Alan Wood Steel Co.
A4 Allegheny Ludlum Steel
A5 Alloy Metal Wire Div., H. K. Porter Co. Inc.
A6 American Shim Steel Co.
A7 American Steel & Wire Div., U. S. Steel Corp.
A8 Anchor Drawn Steel Co.
A9 Angell Nail & Chaplet.
A10 Armco Steel Corp.
A11 Atlantic Steel Co.
A24 Alaska Steel Mills Inc.

B1 Babcock & Wilcox
B2 Bethlehem Steel Co.
B3 Bethlehem Steel Co., Pacific Coast Div.
B4 Blair Strip Steel Co.
B5 Bliss & Laughlin Inc.
B8 Braeburn Alloy Steel
B9 Brainard Steel Div., Sharon Steel Corp.
B10 E. & G. Brooke, Wickwire Spencer Steel Div., Colo. Fuel & Iron
B12 Buffalo Steel Corp.
B14 A. M. Byers Co.
B15 J. Bishop & Co.

C1 Calstrip Steel Corp.
C2 Calumet Steel Div., Borg-Warner Corp.
C4 Carpenter Steel Co.
C9 Colonial Steel Co.
C10 Colorado Fuel & Iron
C11 Columbia-Geneva Steel
C12 Columbia Steel & Shaft.
C13 Columbia Tool Steel Co.
C14 Compressed Steel Shaft.
C15 Connors Steel Div., H. K. Porter Co. Inc.
C16 Continental Steel Corp.
C17 Copperweld Steel Co.
C18 Crucible Steel Co.
C19 Cumberland Steel Co.
C20 Cuyahoga Steel & Wire
C22 Claymont Plant, Wickwire Spencer Steel Div., Colo. Fuel & Iron
C23 Charter Wire Inc.
C24 G. O. Carlson Inc.
C32 Carpenter Steel ofN.Eng.

D2 Detroit Steel Corp.
D4 Disston Div., H. K. Porter Co. Inc.
D6 Driver-Harris Co.
D7 Dickson Weatherproof Nail Co.
D8 Damascus Tube Co.
D9 Wilbur B. Driver Co.

E1 Eastern Gas & Fuel Assoc.
E2 Eastern Stainless Steel
E5 Elliott Bros. Steel Co.
E6 Empire-Reeves Steel Corp.
E10 Enamel Prod. & Plating

F2 Firth Sterling Inc.
F3 Fitzsimmons Steel Co.
F4 Follansbee Steel Corp.
F5 Franklin Steel Div., Borg-Warner Corp.
F6 Fretz-Moon Tube Co.
F7 Ft. Howard Steel & Wire
F8 Ft. Wayne Metals Inc.

G4 Granite City Steel Co.
G5 Great Lakes Steel Corp.
G6 Greer Steel Co.
G8 Green River Steel Corp.

H1 Hanna Furnace Corp.
H7 Helical Tube Co.

I-1 Igoe Bros. Inc.
I-2 Inland Steel Co.
I-3 Interlake Iron Corp.
I-4 Ingersoll Steel Div., Borg-Warner Corp.
I-6 Ivins Steel Tube Works
I-7 Indiana Steel & Wire Co.

J1 Jackson Iron & Steel Co.
J3 Jessop Steel Co.
J4 Johnson Steel & Wire Co.
J5 Jones & Laughlin Steel
J6 Joslyn Mfg. & Supply
J7 Judson Steel Corp.
J8 Jersey Shore Steel Co.

K1 Kaiser Steel Corp.
K2 Keokuk Electro-Metals
K3 Keystone Drawn Steel
K4 Keystone Steel & Wire
K7 Kenmore Metals Corp.

L1 Laclede Steel Co.
L2 LaSalle Steel Co.
L3 Latrobe Steel Co.
L6 Lone Star Steel Co.
L7 Lukens Steel Co.
L8 Leschen Wire Rope Div., H. K. Porter Co. Inc.

M1 McLouth Steel Corp.
M4 Mahoning Valley Steel
M6 Mercer Pipe Div., Sawhill Tubular Products
M8 Mid-States Steel & Wire
M12 Moltrup Steel Products
M14 McInnes Steel Co.
M16 Md. Fine & Specialty Wire Co. Inc.
M17 Metal Forming Corp.
M18 Milton Steel Div., Merritt-Chapman&Scott
M21 Mallory-Sharon Metals Corp.
M22 Mill Strip Products Co.

N1 National-Standard Co.
N2 National Supply Co.
N3 National Tube Div., U. S. Steel Corp.
N5 Nelsen Steel & Wire Co.
N6 New England High Carbon Wire Co.
N8 Newman-Crosby Steel
N14 Northwest. Steel Rolling Mills Inc.
N15 Northwestern S.&W. Co.
N20 Neville Ferro Alloy Co.

O4 Oregon Steel Mills

P1 Pacific States Steel Corp.
P2 Pacific Tube Co.
P4 Phoenix Steel Corp.
P5 Pilgrim Drawn Steel
P6 Pittsburgh Coke & Chem.
P7 Pittsburgh Steel Co.
P11 Pollak Steel Co.
P12 Portsmouth Div., Detroit Steel Corp.
P13 Precision Drawn Steel
P15 Pittsburgh Metallurgical
P16 Page Steel & Wire Div., American Chain & Cable
P17 Plymouth Steel Corp.
P19 Pitts. Rolling Mills
P20 Prod. Steel Strip Corp.
P22 Phoenix Mfg. Co.
P24 Phil. Steel & Wire Corp.

R2 Republic Steel Corp.
R3 Rhode Island Steel Corp.
R5 Roebling's Sons, John A.
R6 Rome Strip Steel Co.
R8 Reliance Div.,EatonMfg.
R9 Rome Mfg. Co.
R10 Rodney Metals Inc.

S1 Seneca Wire & Mfg. Co.
S3 Sharon Steel Corp.
S4 Sharon Tube Co.
S5 Sheffield Div., Armco Steel Corp.
S6 Shenango Furnace Co.
S7 Simmons Co.
S8 Simonds Saw & Steel Co.
S12 Spencer Wire Corp.
S13 Standard Forgings Corp.
S14 Standard Tube Co.
S15 Stanley Works
S17 Superior Drawn Steel Co.
S18 Superior Steel Div., Copperweld Steel Co.
S19 Sweet's Steel Co.
S20 Southern States Steel
S23 Superior Tube Co.
S25 Stainless Welded Prod.
S26 Specialty Wire Co. Inc.
S30 Sierra Drawn Steel Corp.
S40 Seneca Steel Service
S41 Stainless & Strip Div., J&L Steel Corp.
S42 Southern Elec. Steel Co.
S43 Seymour Mfg. Co.
S44 Screw & Bolt Corp. of America

T2 Tenn. Coal & Iron Div., U. S. Steel Corp.
T3 Tenn. Products & Chemical Corp.
T4 Texas Steel Co.
T5 Thomas Strip Div., Pittsburgh Steel Co.
T6 Thompson Wire Co.
T7 Timken Roller Bearing
T9 Tonawanda Iron Div., Am. Rad. & Stan. San.
T13 Tube Methods Inc.
T19 Techalloy Co. Inc.

U3 Union Wire Rope Corp.
U4 Universal-Cyclops Steel
U5 United States Steel Corp.
U6 U. S. Pipe & Foundry
U7 Ulbrich Stainless Steels
U8 U. S. Steel Supply Div., U. S. Steel Corp.
U11 Union Carbide Metals Co.
U13 Union Steel Corp.

V2 Vanadium-Alloys Steel
V3 Vulcan-Kidd Steel Div., H. K. Porter Co.

W1 Wallace Barnes Steel Div., Associated Spring Corp.
W2 Wallingford Steel Co.
W3 Washburn Wire Co.
W4 Washington Steel Corp.
W6 Weirton Steel Co.
W8 Western Automatic Machine Screw Co.
W9 Wheatland Tube Co.
W10 Wheeling Steel Corp.
W12 Wickwire Spencer Steel Div., Colo. Fuel & Iron
W13 Wilson Steel & Wire Co.
W14 Wisconsin Steel Div., International Harvester
W15 Woodward Iron Co.
W18 Wyckoff Steel Co.

Y1 Youngstown Sheet & Tube

STRIP

STRIP, Hot-Rolled Carbon

Ala.City,Ala.(27) R2	5.10
Allenport,Pa. P7	5.10
Alton,Ill. L1	5.30
Ashland,Ky.(8) A10	5.10
Atlanta A11	5.10
Bessemer,Ala. T2	5.10
Birmingham C15	5.10
Buffalo(27) R2	5.10
Conshohocken,Pa. A3	5.15
Detroit M1	5.10
Ecorse,Mich. G5	5.10
Fairfield,Ala. T2	5.10
Farrell,Pa. S3	5.10
Fontana,Calif. K1	5.825
Gary,Ind. U5	5.10
Ind.Harbor,Ind. I-2, Y1	5.10
Johnstown,Pa.(25) B2	5.10
Lackaw'na,N.Y.(25) B2	5.10
LosAngeles(25) B3	5.85
LosAngeles C1	8.60
Minnequa,Colo. C10	6.20
Riverdale,Ill. A1	5.10
SanFrancisco S7	6.60
Seattle(25) B3	6.10
Seattle N14	6.60
Sharon,Pa. S3	5.10
S.Chicago,Ill. W14	5.10
S.SanFrancisco(25) B3	5.85
SparrowsPoint,Md. B2	5.10
Torrance,Calif. C11	5.85
Warren,O. R2	5.10
Weirton,W.Va. W6	5.10
Youngstown U5	5.10

STRIP, Hot-Rolled Alloy

Carnegie,Pa. S18	8.40
Farrell,Pa. S3	8.40
Gary,Ind. U5	8.40
Houston S5	8.65
Ind.Harbor,Ind. Y1	8.40
KansasCity,Mo. S5	8.65
LosAngeles B3	9.60
Lowellville,O. S3	8.40
Newport,Ky. A2	8.40
Sharon,Pa. A2, S3	8.40
S.Chicago,Ill. W14	8.40
Youngstown U5, Y1	8.40

STRIP, Hot-Rolled High-Strength, Low-Alloy

Ashland,Ky. A10	7.575
Bessemer,Ala. T2	7.575
Conshohocken,Pa. A3	7.575
Ecorse,Mich. G5	7.575
Fairfield,Ala. T2	7.575
Farrell,Pa. S3	7.575
Gary,Ind. U5	7.575
Ind.Harbor,Ind. I-2, Y1	7.575
Lackawanna,N.Y. B2	7.575
LosAngeles(25) B3	8.325
Seattle(25) B3	8.575
Sharon,Pa. S3	7.575
S.Chicago,Ill. W14	7.575
S.SanFrancisco(25) B3	8.325
SparrowsPoint,Md. B2	7.575
Warren,O. R2	7.575
Weirton,W.Va. W6	7.575
Youngstown U5, Y1	7.575

STRIP, Hot-Rolled Ingot Iron

Ashland,Ky.(8) A10	5.35
Warren,O. R2	5.875

STRIP, Cold-Rolled Carbon

Anderson,Ind. G6	7.425
Baltimore T6	7.425
Boston T6	7.975
Buffalo S40	7.425
Cleveland A7, J5	7.425
Dearborn,Mich. S3	7.425
Detroit D2, M1, P20	7.425
Dover,O. G6	7.425
Evanston,Ill. M22	7.525
Farrell,Pa. S3	7.425
Follansbee,W.Va. W10	7.425
Fontana,Calif. K1	9.20
FranklinPark,Ill. T6	7.525
Ind.Harbor,Ind. Y1	7.425
Indianapolis S41	7.575
LosAngeles C1, S41	9.30
McKeesport,Pa. E10	7.525
NewBedford,Mass. R10	7.875
NewBritain,Conn. S15	7.875
NewCastle,Pa. B4, E5	7.425
NewHaven,Conn. D2	7.875
NewKensington,Pa. A6	7.425
Pawtucket,R.I. R3	7.975
Pawtucket,R.I. N8	7.975
Philadelphia P24	7.875
Pittsburgh J5	7.425
Riverdale,Ill. A1	7.525
Rome,N.Y.(32) R6	7.425
Sharon,Pa. S3	7.425
Trenton,N.J.(31) R5	8.875
Wallingford,Conn. W2	7.875
Warren,O. R2, T5	7.425
Worcester,Mass. A7	7.975

STRIP, Cold-Rolled Alloy

Boston T6	15.90
Carnegie,Pa. S18	15.55
Cleveland A7	15.55
Dover,O. G6	15.55
Farrell,Pa. S3	15.55
FranklinPark,Ill. T6	15.55
Harrison,N.J. C18	15.55
Indianapolis S41	15.70
LosAngeles S41	17.75
Lowellville,O. S3	15.55
Pawtucket,R.I. N8	15.90
Riverdale,Ill. A1	15.55
Sharon,Pa. S3	15.55
Worcester,Mass. A7	15.85
Youngstown S41	15.55

STRIP, Cold-Rolled High-Strength, Low-Alloy

Cleveland A7	10.80
Dearborn,Mich. S3	10.80
Dover,O. G6	10.80
Farrell,Pa. S3	10.80
Ind.Harbor,Ind. Y1	10.80
Sharon,Pa. S3	10.80
Warren,O. R2	10.80

STRIP, Cold-Finished Spring Steel (Annealed)	0.26-0.40C	0.41-0.60C	0.61-0.80C	0.81-1.05C	1.06-1.35C
Baltimore T6	9.50	10.70	12.90	15.90	18.85
Boston T6	9.50	10.70	12.90	15.90	18.85
Bristol,Conn. W1	....	10.70	12.90	16.10	19.30
Carnegie,Pa. S18	8.95	10.40	12.60	15.60	....
Cleveland A7	8.95	10.40	12.60	15.60	18.55
Dearborn,Mich. S3	9.05	10.50	12.70	....	....
Detroit D2	9.05	10.50	12.70	15.70	....
Dover,O. G6	8.95	10.40	12.60	15.60	18.55
Evanston,Ill. M22	8.95	10.40	12.60	15.60	....
Farrell,Pa. S3	8.95	10.40	12.60	15.60	18.55
Fostoria,O. S1	10.05	10.40	12.60	15.60	....
FranklinPark,Ill. T6	9.05	10.40	12.60	15.60	18.55
Harrison,N.J. C18	....	....	12.90	16.10	19.30
Indianapolis S41	9.10	10.55	12.60	15.60	18.55
LosAngeles C1	11.15	12.60	14.80	17.80	....
LosAngeles S41	11.15	12.60	14.80	....	....
NewBritain,Conn. S15	9.40	10.70	12.90	15.90	18.85
NewCastle,Pa. B4, E5	8.95	10.40	12.60	15.60	....
NewHaven,Conn. D2	9.40	10.70	12.90	15.90	....
NewKensington,Pa. A6	9.85	10.40	12.60	15.60	....
NewYork W3	....	10.70	12.90	16.10	19.30
Pawtucket,R.I. N8	9.50	10.70	12.90	15.90	18.85
Riverdale,Ill. A1	9.05	10.40	12.60	15.60	18.55
Rome,N.Y.(32) R6	8.95	10.40	12.60	15.60	18.55
Sharon,Pa. S3	8.95	10.40	12.60	15.60	18.55
Trenton,N.J. R5	....	10.70	12.90	15.90	18.85
Wallingford,Conn. W2	9.40	10.70	12.90	15.90	18.75
Warren,O. T5	8.95	10.40	12.60	15.60	18.55
Worcester,Mass. A7, T6	9.50	10.70	12.90	15.90	18.85
Youngstown S41	8.95	10.40	12.60	15.60	18.55

Spring Steel (Tempered)			Up to 0.80C	0.81-1.05C	1.06-1.35C
Bristol,Conn. W1	....	....	18.85	22.95	27.80
Buffalo W12	....	....	18.85	....	....
Fostoria,O. S1	....	....	19.05	22.15	....
FranklinPark,Ill. T6	....	....	19.20	23.30	28.15
Harrison,N.J. C18	....	....	18.85	22.95	27.80
NewYork W3	....	....	18.85	22.95	27.80
Palmer,Mass. W12	....	....	18.85	....	....
Trenton,N.J. R5	....	....	18.85	22.95	27.80
Worcester,Mass. A7, T6	....	....	18.85	22.95	27.80
Youngstown S41	....	....	19.20	23.30	28.15

Weirton,W.Va. W6 ....10.80
Youngstown Y1 .....10.80

STRIP, Cold-Rolled Ingot Iron

Warren,O. R2 .....8.175

STRIP, C.R. Electrogalvanized

Cleveland A7	7.425*
Dover,O. G6	7.425*
Evanston,Ill. M22	7.525*
McKeesport,Pa. E10	7.50*
Riverdale,Ill. A1	7.525*
Warren,O. B9, S3, T5	7.425*
Worcester,Mass. A7	7.975
Youngstown S41, Y1	7.425*

*Plus galvanizing extras.

STRIP, Galvanized (Continuous)

Farrell,Pa. S3	7.50
Sharon,Pa. S3	7.50

TIGHT COOPERAGE HOOP

Atlanta A11	5.65
Farrell,Pa. S3	5.525
Riverdale,Ill. A1	5.675
Sharon,Pa. S3	5.525
Youngstown U5	5.525

SILICON STEEL

C.R. COILS & CUT LENGTHS (22 Ga.)

Fully Processed (Semiprocessed ½c lower)	Field	Armature	Electric	Motor	Dynamo
BeechBottom,W.Va. W10	....	11.70	12.40	13.35	14.65
Brackenridge,Pa. A4	....	....	12.40	13.55	14.65
GraniteCity,Ill. G4	9.975*	11.30*	12.00*	13.15*	....
IndianaHarbor,Ind. I-2	9.875*	11.20*	11.90*	13.05*	....
Mansfield,O. E6	9.875*	11.70	12.40	13.55	14.65
Newport,Ky. A2	9.875	11.70*	12.40*	13.55*	14.65*
Niles,O. M21	9.875*	11.70	12.40	13.55	....
Vandergrift,Pa. U5	9.875*	11.70	12.40	13.55	14.65
Warren,O. R2	9.875*	11.70	12.40	13.55	14.65
Zanesville,O. A10	....	11.70†	12.40	13.55	14.65

	Stator
Vandergrift,Pa. U5	8.10
Mansfield,O. E6	8.10
Warren,O. R2 (Silicon Lowcore)	8.10

SHEETS (22 Ga., coils & cut lengths) Fully Processed (Semiprocessed ½c lower)	T-72	T-65	T-58	T-52
BeechBottom,W.Va. W10	15.70	16.30	16.80	17.85
Vandergrift,Pa. U5	15.70	16.30	16.80	17.85
Zanesville,O. A10	15.70	16.30	16.80	17.85

C.R. COILS & CUT LENGTHS (22 Ga.)	Grain Oriented T-100	T-90	T-80	T-73	T-66	T-72
Brackenridge,Pa. A4	....	18.10	19.70	20.20	20.70	15.70††
Butler,Pa. A10	....	....	....	19.70	20.20	20.70
Vandergrift,Pa. U5	17.10	18.10	19.70	20.20	20.70	15.70
Warren,O. R2	....	....	....	....	....	15.70‡

*Semiprocessed. †Fully processed only. ‡Coils, annealed; semiprocessed ½c lower. ††Coils only.

TIN MILL PRODUCTS

TIN PLATE, Electrolytic (Base Box)	0.25 lb	0.50 lb	0.75 lb
Aliquippa,Pa. J5	$9.10	$9.35	$9.75
Fairfield,Ala. T2	9.20	9.45	9.85
Fairless,Pa. U5	9.20	9.45	9.85
Fontana,Calif. K1	9.75	10.00	10.40
Gary,Ind. U5	9.10	9.35	9.75
GraniteCity,Ill. G4	9.20	9.45	9.60
IndianaHarbor,Ind. I-2, Y1	9.10	9.35	9.75
Irvin,Pa. U5	9.10	9.35	9.75
Niles,O. R2	9.10	9.35	9.75
Pittsburg,Calif. C11	9.75	10.00	10.40
SparrowsPoint,Md. B2	9.10	9.35	9.75
Weirton,W.Va. W6	9.10	9.35	9.75
Yorkville,O. W10	9.10	9.35	9.75

ELECTROLYTIC TIN-COATED SHEET (Dollars per 100 lb)			
IndianaHarbor,Ind. Y1 (20-27 Ga.)	7.90	....	....
Niles,O. R2 (20-27 Ga.)	7.90	8.10	8.30
Aliquippa,Pa. J5 (21-27 Ga.)	7.90	8.10	....

TIN PLATE, Hot Dipped Common Coke	1.25 lb	1.50 lb
Aliquippa,Pa. J5	$10.40	$10.65
Fairfield,Ala. T2	10.50	10.75
Fontana,Calif. K1	11.05	11.30
Gary,Ind. U5	10.40	10.65
Ind.Harb. Y1	10.40	10.65
Irvin,Pa. U5	10.40	10.65
Pitts.,Calif. C11	11.05	11.30
Sp.Pt.,Md. B2	10.40	10.65
Weirton,W.Va. W6	10.40	10.65
Yorkville,O. W10	10.40	10.65

BLACK PLATE (Base Box)

Aliquippa,Pa. J5	$8.20
Fairfield,Ala. T2	8.30
Fairless,Pa. U5	8.30
Fontana,Calif. K1	8.85
Gary,Ind. U5	8.20
GraniteCity,Ill. G4	8.30
Ind.Harbor,Ind. I-2, Y1	8.20
Irvin,Pa. U5	8.20
Niles,O. R2	8.20
Pittsburg,Calif. C11	8.85
SparrowsPoint,Md. B2	8.20
Weirton,W.Va. W6	8.20
Yorkville,O. W10	8.20

HOLLOWARE ENAMELING Black Plate (29 Gage)

Aliquippa,Pa. J5	7.85
Gary,Ind. U5	7.85
GraniteCity,Ill. G4	7.95
Ind.Harbor,Ind. Y1	7.85
Irvin,Pa. U5	7.85
Yorkville,O. W10	7.85

MANUFACTURING TERNES (Special Coated, Base Box)

Gary,Ind. U5	$10.05
Irvin,Pa. U5	10.05

WIRE

WIRE, Manufacturers Bright, Low Carbon

AlabamaCity,Ala. R2	8.00
Aliquippa,Pa. J5	8.00
Alton,Ill. L1	8.20
Atlanta A1	8.00
Bartonville,Ill. K4	8.10
Buffalo W12	8.00
Chicago W13	8.00
Cleveland A7, C20	8.00
Crawfordsville,Ind. M8	8.10
Donora,Pa. A7	8.00
Duluth A7	8.00
Fairfield,Ala. T2	8.00
Fostoria,O.(24) S1	8.10
Houston S5	8.25
Jacksonville,Fla. M8	8.35
Johnstown,Pa. B2	8.00
Joliet,Ill. A7	8.00
KansasCity,Mo. S5	8.25
Kokomo,Ind. C16	8.10
LosAngeles B3	8.95
Minnequa,Colo. C10	8.25
Monessen,Pa. P7, P16	8.00
Palmer,Mass. W12	8.30
Pittsburg,Calif. C11	8.95
Portsmouth,O. P12	8.00
Rankin,Pa. A7	8.00
S.Chicago,Ill. R2	8.00
S.SanFrancisco C10	8.95
SparrowsPoint,Md. B2	8.10
Sterling,Ill.(1) N15	8.00
Sterling,Ill. N15	8.10
Struthers,O. Y1	8.00
Waukegan,Ill. A7	8.00
Worcester,Mass. A7	8.30

WIRE, Cold Heading Carbon

Elyria,O. W8	8.00

WIRE, Gal'd., for ACSR

Bartonville,Ill. K4	12.65
Buffalo W12	13.40
Cleveland A7	12.65
Donora,Pa. A7	12.65
Duluth A7	12.65
Johnstown,Pa. B2	13.40
KansasCity,Mo. U3	12.90
Minnequa,Colo. C10	12.775
Monessen,Pa. P7, P16	12.65
Muncie,Ind. I-7	13.60
NewHaven,Conn. A7	12.95
Palmer,Mass. W12	13.70
Pittsburg,Calif. C11	13.45
Portsmouth,O. P12	12.65
Roebling,N.J. R5	12.95
SparrowsPt.,Md. B2	13.50
Struthers,O. Y1	13.40
Trenton,N.J. A7	12.95
Waukegan,Ill. A7	12.65
Worcester,Mass. A7	12.95

WIRE, Upholstery Spring

Aliquippa,Pa. J5	9.75
Alton,Ill. L1	9.95
Buffalo W12	9.75
Cleveland A7	9.75
Donora,Pa. A7	9.75
Duluth A7	9.75
Johnstown,Pa. B2	9.75
KansasCity,Mo. S5, U3	10.00
LosAngeles B3	10.70
Minnequa,Colo. C10	9.95
Monessen,Pa. P7, P16	9.75
NewHaven,Conn. A7	10.05
Palmer,Mass. W12	10.05
Pittsburg,Calif. C11	10.70
Portsmouth,O. P12	9.75
Roebling,N.J. R5	10.05
S.Chicago,Ill. R2	9.75
S.SanFrancisco C10	10.70
SparrowsPt.,Md. B2	9.85
Struthers,O. Y1	9.75
Trenton,N.J. A7	10.05
Waukegan,Ill. A7	9.75
Worcester,Mass. A7	10.05

WIRE, MB Spring, High-Carbon

Aliquippa,Pa. J5	9.75
Alton,Ill. L1	9.95
Bartonville,Ill. K4	9.85
Buffalo W12	9.75
Cleveland A7	9.75
Donora,Pa. A7	9.75
Duluth A7	9.75
Fostoria,O. S1	9.80
Johnstown,Pa. B2	9.75
KansasCity,Mo. S5, U3	10.00
LosAngeles B3	10.70
Milbury,Mass.(12) N6	10.05
Minnequa,Colo. C10	9.95
Monessen,Pa. P7, P16	9.75
Muncie,Ind. I-7	9.95
Palmer,Mass. W12	10.05
Pittsburg,Calif. C11	10.70
Portsmouth,O. P12	9.75
Roebling,N.J. R5	10.05
S.Chicago,Ill. R2	9.75
S.SanFrancisco C10	10.70
SparrowsPt.,Md. B2	9.85
Struthers,O. Y1	9.75
Trenton,N.J. A7	10.05
Waukegan,Ill. A7	9.75
Wor'ster,Mass.A7,J4,T6	10.05

WIRE, Fine & Weaving(8" Coils)

Alton,Ill. L1	16.50
Bartonville,Ill. K4	16.40
Chicago W13	16.30
Cleveland A7	16.30
Crawfordsville,Ind. M8	16.40
Fostoria,O. S1	16.30
Houston S5	16.55
Jacksonville,Fla. M8	16.65
Johnstown,Pa. B2	16.30
KansasCity,Mo. S5	16.55
Kokomo,Ind. C16	16.30
Minnequa,Colo. C10	16.55
Monessen,Pa. P16	16.30
Muncie,Ind. I-7	16.50
Palmer,Mass. W12	16.60
S.SanFrancisco C10	17.15
Waukegan,Ill. A7	16.30
Worcester,Mass. A7, J6	16.60

WIRE, Tire Bead

Bartonville,Ill. K4	17.15
Monessen,Pa. P16	17.15
Roebling,N.J. R5	17.65

ROPE WIRE (A)

Bartonville,Ill. K4	13.45
Buffalo W12	13.45
Fostoria,O. S1	13.45
KansasCity,Mo. U3	13.70
Johnstown,Pa. B2	13.45
Monessen,Pa. P7	13.45
Muncie,Ind. I-7	13.65
Palmer,Mass. W12	13.75
Portsmouth,O. P12	13.45
Roebling,N.J. R5	13.75
St.Louis L8	13.45
SparrowsPt.,Md. B2	13.56
Struthers,O. Y1	13.45
Worcester,Mass. J4	13.75

(A) Plow and Mild Plow; add 0.25c for Improved Plow.

Wire, Cold-Rolled Flat

Anderson,Ind. G6	12.35
Baltimore T6	12.65
Boston T6	12.65
Buffalo W12	12.35
Chicago W13	12.45
Cleveland A7	12.35
Crawfordsville,Ind. M8	12.35
Dover,O. G6	12.35
Farrell,Pa. S3	12.35
Fostoria,O. S1	12.35
FranklinPark,Ill. T6	12.45
Kokomo,Ind. C16	12.35
Massillon,O. R8	12.35
Milwaukee C23	12.55
Monessen,Pa. P7, P16	12.35
Palmer,Mass. W12	12.65
Pawtucket,R.I. N8	12.65
Philadelphia P24	12.65
Riverdale,Ill. A1	12.45
Rome,N.Y. R6	12.35
Sharon,Pa. S3	12.35
Trenton,N.J. R5	12.65
Warren,O. B9	12.35
Worcester,Mass. A7,T6	12.65

NAILS, Stock — **Col.**

AlabamaCity,Ala. R2	173
Aliquippa,Pa. J5	173
Atlanta A11	175
Bartonville,Ill. K4	175
Chicago W13	173
Cleveland A9	173
Crawfordsville,Ind. M8	175
Donora,Pa. A7	173
Duluth A7	173
Fairfield,Ala. T2	173
Houston S5	178
Jacksonville,Fla. M8	175
Johnstown,Pa. B2	173
Joliet,Ill. A7	173
KansasCity,Mo. S5	178
Kokomo,Ind. C16	175
Minnequa,Colo. C10	178
Monessen,Pa. P7	173
Pittsburg, Calif. C11	192
Rankin,Pa. A7	173
S.Chicago,Ill. R2	173
SparrowsPt.,Md. B2	175
Sterling,Ill.(7) N15	175
Worcester,Mass. A7	179

(To Wholesalers: per cwt)

Galveston,Tex. D7	$10.30

NAILS, Cut (100 lb keg) to Distributors (33)

Wheeling,W.Va. W10	$10.10

POLISHED STAPLES — **Col.**

AlabamaCity,Ala. R2	175
Aliquippa,Pa. J5	173
Atlanta A11	177
Bartonville,Ill. K4	175
Crawfordsville,Ind. M8	177
Donora,Pa. A7	173
Duluth A7	173
Fairfield,Ala. T2	173
Houston S5	180
Jacksonville,Fla. M8	177
Johnstown,Pa. B2	175
Joliet,Ill. A7	173
KansasCity,Mo. S5	180
Kokomo,Ind. C16	177
Minnequa,Colo. C10	180
Pittsburg,Calif. C11	194
Rankin,Pa. A7	173
S.Chicago,Ill. R2	175
SparrowsPt.,Md. B2	177
Sterling,Ill.(7) N15	175
Worcester,Mass. A7	181

TIE WIRE, Automatic Baler (14½ Ga.)(per 97 lb Net Box) Coil No. 3150

AlabamaCity,Ala. R2	$9.24
Atlanta A11	10.36
Bartonville,Ill. K4	9.34
Buffalo W12	10.26
Chicago W13	9.24
Crawfordsville,Ind. M8	9.34
Donora,Pa. A7	9.24
Duluth A7	9.24
Fairfield,Ala. T2	9.24
Houston S5	10.51
Jacksonville,Fla. M8	9.34
Johnstown,Pa. B2	10.26
Joliet,Ill. A7	9.24
KansasCity,Mo. S5	10.51
Kokomo,Ind. C16	9.34
LosAngeles B3	11.05
Minnequa,Colo. C10	10.51
Pittsburg,Calif. C11	9.94
S.Chicago, Ill. R2	9.24
S.SanFrancisco C10	11.04
SparrowsPt.,Md. B2	10.36
Sterling,Ill.(37) N15	9.34

Coil No. 6500 Stand.

AlabamaCity,Ala. R2	$9.54
Atlanta A11	10.70
Bartonville,Ill. K4	9.64
Buffalo W12	10.60
Chicago W13	9.54
Crawfordsville,Ind. M8	9.64
Donora,Pa. A7	9.54
Duluth A7	9.54
Fairfield,Ala. T2	9.54
Houston S5	10.85
Jacksonville,Fla. M8	9.64
Johnstown,Pa. B2	10.60
Joliet,Ill. A7	9.54
KansasCity,Mo. S5	10.85
Kokomo,Ind. C16	9.64
LosAngeles B3	11.40
Minnequa,Colo. C10	10.85
Pittsburg,Calif. C11	10.26
S.Chicago,Ill. R2	9.54
S.SanFrancisco C10	11.40
SparrowsPt.,Md. B2	10.70
Sterling,Ill.(37) N15	9.64

Coil No. 6500 Interim

AlabamaCity,Ala. R2	$9.59
Atlanta A11	10.75
Bartonville,Ill. K4	9.69
Buffalo W12	10.65
Chicago W13	9.59
Crawfordsville,Ind. M8	9.69
Donora,Pa. A7	9.59
Duluth A7	9.59
Fairfield,Ala. T2	9.59
Houston S5	10.90
Jacksonville,Fla. M8	9.69
Johnstown,Pa. B2	10.65
Joliet,Ill. A7	9.59
KansasCity,Mo. S5	10.90
Kokomo,Ind. C16	9.69
LosAngeles B3	11.45
Minnequa,Colo. C10	10.90
Pittsburg,Calif. C11	10.31
S.Chicago,Ill. R2	9.59
S.SanFrancisco C10	11.45
SparrowsPt.,Md. B2	10.75
Sterling,Ill.(37) N15	9.69

BALE TIES, Single Loop — **Col.**

AlabamaCity,Ala. R2	212
Atlanta A11	214
Bartonsville,Ill. K4	214
Crawfordsville,Ind. M8	214
Donora,Pa. A7	212
Duluth A7	212
Fairfield,Ala. T2	212
Houston S5	217
Jacksonville,Fla. M8	214
Joliet,Ill. A7	212
KansasCity,Mo. S5	217
Kokomo,Ind. C16	214
Minnequa,Colo. C10	217
Pittsburg,Calif C11	236
S.SanFrancisco C10	236
SparrowsPt.,Md. B2	214
Sterling,Ill.(7) N15	214

FENCE POSTS — **Col.**

Birmingham C15	177
ChicagoHts.,Ill. C2, I-2	177
Duluth A7	177
Franklin,Pa. F5	177
Johnstown,Pa. B2	177
Marion,O. P11	177
Minnequa,Colo. C10	182
Tonawanda,N.Y. B12	177

WIRE, Barbed — **Col.**

AlabamaCity,Ala. R2	193••
Aliquippa,Pa. J5	190§
Atlanta A11	198§
Bartonville,Ill. K4	198
Crawfordsville,Ind. M8	198
Donora,Pa. A7	193†
Duluth A7	193†
Fairfield, Ala. T2	193†
Houston S5	198••
Jacksonville,Fla. M8	198
Johnstown,Pa. B2	196§
Joliet,Ill A7	193†
KansasCity,Mo. S5	198••
Kokomo,Ind. C16	195†
Minnequa,Colo. C10	198••
Monessen,Pa. P7	196§
Pittsburg,Calif. C11	213†
Rankin,Pa. A7	193†
S.Chicago,Ill. R2	193••
S.SanFrancisco C10	213•
SparrowsPoint,Md. B2	198§
Sterling,Ill.(7) N15	198

WOVEN FENCE, 9-15 Ga. — **Col.**

Ala.City,Ala. R2	187••
Aliq'ppa,Pa.9-11½ga.J5	190§
Atlanta A11	192§
Bartonville,Ill. K4	192
Crawfordsville,Ind. M8	192
Donora,Pa. A7	187†
Duluth A7	187†
Fairfield,Ala. T2	187†
Houston S5	192••
Jacksonville,Fla. M8	192
Johnstown,Pa.(43) B2	190§
Joliet,Ill. A7	187†
KansasCity,Mo. S5	192••
Kokomo,Ind. C16	189†
Minnequa,Colo. C10	192••
Pittsburg,Calif. C11	210†
Rankin,Pa. A7	187†
S.Chicago,Ill. R2	187••
Sterling,Ill.(7) N15	192

WIRE (16 gage)

	An'ld Galv.	Stone
Ala.City,Ala.R2	17.85	19.40••
Aliq'ppa,Pa. J5	17.85	19.65
Bartonville K4	17.95	19.80
Cleveland A7	17.85	....
Craw'dville B8	17.95	19.80‡‡
Fostoria,O. S1	18.35	19.90†
Houston S5	18.10	19.65••
Jacksonville M8	18.95	19.80‡‡
Johnstown B2	17.85	19.65§
Kan.City,Mo. S5	18.10	....
Kokomo C16	17.25	18.80†
Minnequa C10	18.10	19.65••
P'lm'r,Mass. W12	18.15	19.70†
Pitts.,Calif. C11	18.20	19.75†
S.SanFran. C10	18.20	19.75••
St'ling(37) N15	17.95	19.80
SparrowsPt. B2	17.95	19.75§
Waukegan A7	17.85	19.40†
Worcester A7	18.15	....

WIRE, Merchant quality (6 to 8 gage) — **An'ld Galv.**

Ala.City,Ala. R2	9.00 9.55••
Aliquippa J5	8.65 9.325§
Atlanta(48)A11	9.10 9.775§
Bartonville(48) K4	9.10 9.80
Buffalo W12	9.00 9.55†
Cleveland A7	9.00 ....
Crawfordsville M8	9.10 9.80††
Donora,Pa. A7	9.00 9.55†
Duluth A7	9.00 9.55†
Fairfield T2	9.00 9.55†
Houston(48) S5	9.25 9.80••
Jack'ville,Fla. M8	9.10 9.80‡‡
Johnstown(48) B2	9.00 9.675§
Joliet,Ill. A7	9.00 9.55†
KansCity(48) S5	9.25 9.80••
Kokomo(48) S16	9.10 9.65†
LosAngeles B3	9.95 10.625§
Monessen(48) P7	8.65 9.35§
Palmer,Mass. W12	9.30 9.85†
Pitts.,Calif. C11	9.95 10.50†
Rankin,Pa. A7	9.00 9.55†
S.Chicago R2	9.00 9.55••
S.SanFran. C10	9.95 10.50••
Spar'wsPt.(48)B2	9.10 9.775§
St'ling(37)(48)	N15 9.10 9.80
Struthers,O. Y1	9.00 9.65‡
Worcester,Mass.A7	9.30 9.85†

Based on zinc price of: •13.50. †5c. ‡10c. ‡‡Less than 10c. ††10.50c. ‡‡11.00c. ••Subject to zinc equalization extras.

FASTENERS

(Base discounts, shipments of one to four containers, per cent off list, f.o.b. mill)

BOLTS

Machine Bolts
Full Size Body (cut thread)

½ in. and smaller:	
3 in. and shorter	55.0
3¼ in. thru 6 in.	50.0
Longer than 6 in.	37.0
⅝ in., 3 in. & shorter	47.0
3¼ in. thru 6 in.	40.0
Longer than 6 in.	31.0
¾ in. thru 1 in.:	
6 in. and shorter	37.0
Longer than 6 in.	31.0
1⅛ in. and larger:	
All lengths	31.0

Undersize Body (rolled thread)

½ in. and smaller:	
3 in. and shorter	55.0
3¼ in. thru 6 in.	50.0

Carriage Bolts
Full Size Body (cut thread) & Undersize Body (rolled thread)

½ in. and smaller:	
6 in. and shorter	48.0
Larger diameters and longer lengths	35.0

Lag, Plow, Tap, Blank, Step, Elevator, Tire, and Fitting Up Bolts

½ in. and smaller:	
6 in. and shorter	48.0
Larger diameters and longer lengths	35.0

High Tensile Structural Bolts (Reg. semifinished hex head bolts, heavy semifinished hex nuts. Bolts — High-carbon steel, heat treated, Spec. (ASTM A-325, in bulk. Full keg quantity)

⅝ in. diam	50.0
¾ in. diam	47.0
⅞ and 1 in. diam	43.0
1⅛ and 1¼ in. diam	34.0

NUTS
(Keg or case quantity and over)

Square Nuts, Reg. & Heavy:

All sizes	56.0

(Full container)

Hex Nuts, Reg. & Heavy

Hot Pressed & Cold Punched:	
¾ in. and smaller	62.0
⅞ in. to 1½ in., incl.	56.0
1⅝ in. and larger	51.5
Hex Nuts, Semifinished, Heavy (Incl. Slotted):	
¾ in. and smaller	62.0
⅞ in. to 1½ in. incl.	56.0
1⅝ in. and larger	51.5
Hex Nuts, Finished (Incl. Slotted and Castellated):	
⅞ in. and smaller	65.0
1 in. to 1½ in., incl.	57.0
1⅝ in. and larger	51.5
Semifinished Hex Nuts, Reg. (Incl. Slotted):	
⅝ in. and smaller	62.0
¾ in. to ⅞ in., incl.	65.0
1 in. to 1½ in., incl.	57.0
1⅝ in. and larger	51.5

CAP AND SETSCREWS
(Base discounts, packages, per cent off list, f.o.b. mill)

Hex Head Cap Screws, Coarse or Fine Thread, Bright:

6 in. and shorter:	
⅝ in. and smaller	35.0
¾, ⅞, and 1 in.	16.0
Longer than 6 in.:	
⅝ in. and smaller	3.0
¾, ⅞, and 1 in.	+11.0
High Carbon, Heat Treated:	
6 in. and shorter:	
⅝ in. and smaller	20.0
¾, ⅞, and 1 in.	+ 5.0
Longer than 6 in.:	
⅝ in. and smaller	+19.0
¾, ⅞, and 1 in.	+39.0
Flat Head Cap Screws:	
¾ in. and smaller, 6 in. and shorter	+85.0
Setscrews, Square Head, Cup Point, Coarse Thread:	
Through 1 in. diam:	
6 in. and shorter	+ 5.0
Longer than 6 in.	+29.0

RIVETS

F.o.b. Cleveland and/or freight equalized with Pittsburgh, f.o.b. Chicago and/or freight equalized with Birmingham except where equalization is too great.

Structural ½ in., larger 12.85, 7/16 in. and smaller by 6 in. and shorter: 15% off list.

BOILER TUBES

Net base c.l. prices, dollars per 100 ft, mill; minimum wall thickness, cut lengths 10 to 24 ft, inclusive.

O.D. In.	B.W. Gage	Seamless H.R.	Seamless C.D.	Elec. Weld H.R.
1	13	....	27.24	23.13
1¼	13	....	32.25	24.41
1½	13	30.42	35.65	26.98
1¾	13	35.94	42.12	31.89
2	13	40.28	47.21	35.74
2¼	13	45.36	53.17	40.26
2½	12	49.24	57.72	43.70
2¼	12	54.23	63.57	48.13
2½	12	58.73	68.83	52.13
2¾	12	62.62	73.40	55.59
3	12	....	....	....

RAILWAY MATERIALS

Rails	Standard No. 1	Standard No. 2	Tee Rails All No. 2	Tee Rails 60 lb and Under
Bessemer,Pa. U5	5.75	5.60	....	6.725
Ensley,Ala. T2	5.75	5.65	....	6.725
Fairfield,Ala. T2	....	....	....	6.725
Gary,Ind. U5	5.75	5.65	....	....
Huntington,W.Va. C15	....	....	....	....
Johnstown,Pa. B2	....	....	....	(16)6.725
Lackawanna,N.Y. B2	5.75	5.65	....	6.725
Minnequa,Colo. C10	5.75	5.65	....	7.225
Steelton,Pa. B2	5.75	5.65	....	....
Williamsport,Pa. S19	....	....	....	6.725

TIE PLATES

Fairfield,Ala. T2	6.875
Gary,Ind. U5	6.875
Lackawanna,N.Y. B2	6.875
Minnequa,Colo C10	6.875
Seattle B3	7.025
Steelton,Pa. B2	6.875
Torrance,Calif. C11	6.875

JOINT BARS

Bessemer, Pa. U5	7.25
Fairfield,Ala. T2	7.25
Joliet,Ill. U5	7.25
Lackawanna,N. Y. B2	7.25
Minnequa,Colo. C10	7.25
Steelton,Pa. B2	7.25

AXLES

Ind.Harbor,Ind. S13	9.125
Johnstown,Pa. B2	9.125

TRACK BOLTS, Untreated

Cleveland R2	15.35
KansasCity,Mo. S5	15.35
Lebanon,Pa. B2	15.35
Minnequa,Colo. C10	15.35
Pittsburgh S44	14.75
Seattle B3	15.85

SCREW SPIKES

Lebanon, Pa. B2	15.10

STANDARD TRACK SPIKES

Fairfield,Ala. T2	10.10
Ind.Harbor,Ind. I-2,Y1	10.10
KansasCity,Mo. S5	10.10
Lebanon,Pa. B2	10.10
Minnequa,Colo. C10	10.10
Pittsburgh J5	10.10
Seattle B3	10.60
S.Chicago,Ill. R2	10.10
Struthers,O. Y1	10.10
Youngstown R2	10.10

Footnotes

(1) Chicago base.
(2) Angles, flats, bands.
(3) Merchant.
(4) Reinforcing.
(5) 1⅛ to under 1 7/16 in.; 1 7/16 to under 1 15/16 in., 6.70c; 1 15/16 to 8 in., inclusive, 7.05c.
(6) Chicago or Birm. base.
(7) Chicago base 2 cols. lower.
(8) 16 Ga. and heavier.
(9) Merchant quality; add 0.35c for special quality.
(10) Pittsburgh base.
(11) Cleveland & Pitts. base.
(12) Worcester, Mass., base.
(13) Add 0.25c for 17 Ga & heavier.
(14) Gage 0.143 to 0.249 in.; for gage 0.142 and lighter, 5.80c.
(15) ¾" and thinner.
(16) 40 lb and under.
(17) Flats only; 0.25 in. & heavier.
(18) To dealers.
(19) Chicago & Pitts. base.
(21) New Haven, Conn., base.
(22) Deld. San Francisco Bay area.
(23) Special quality.
(24) Deduct 0.05c, finer than 15 Ga.
(25) Bar mill bands.
(26) Deld. in mill zone, 6.295c.
(27) Bar mill sizes.
(28) Bonderized.
(29) Youngstown base.
(30) Sheared; for universal mill add 0.45c.
(31) Widths over ⅝ in.; 7.375c, for widths ⅝ in. and under by 0.125 in. and thinner.
(32) Buffalo base.
(33) To jobbers, deduct 20c.
(34) 9.60c for cut lengths.
(35) 72" and narrower.
(36) 54" and narrower.
(37) Chicago base, 10 points lower.
(38) 13 Ga. & lighter; 60" & narrower.
(39) 48" and narrower.
(40) Lighter than 0.035"; 0.035" and heavier, 0.25c higher.
(41) 9.10c for cut lengths.
(42) Mill lengths, f.o.b. mill; deld. in mill zone or within switching limits, 5.635c.
(43) 9-14½ Ga.
(44) To fabricators.
(48) 6-7 Ga.
(49) 3½ in. and smaller rounds; 9.65, over 3½ in. and other shapes.

SEAMLESS STANDARD PIPE, Threaded and Coupled

Carload discounts from list, %

Size—Inches	2		2½		3		3½		4		5		6	
List Per Ft	37c		58.5c		76.5c		92c		$1.09		$1.48		$1.92	
Pounds Per Ft	3.68		5.82		7.62		9.20		10.89		14.81		19.18	
	Blk	Galv*	Blk	Galv*	Blk	Galv*	Blk	Galv*	Blk	Galv*	Blk	Galv*	Blk	Galv*
Aliquippa, Pa. J5	+12.25	+27.25	+5.75	+22.5	+3.25	+20	+1.75	+18.5	+1.75	+18.5	+2	+18.75	0.5	+16.25
Ambridge, Pa. N2	+12.25	....	+5.75	....	+3.25	....	+1.75	....	+1.75	....	+2	....	0.5	....
Lorain, O. N3	+12.25	+27.25	+5.75	+22.5	+3.25	+20	+1.75	+18.5	+1.75	+18.5	+2	+18.75	0.5	+16.25
Youngstown Y1	+12.25	+27.25	+5.75	+22.5	+3.25	+20	+1.75	+18.5	+1.75	+18.5	+2	+18.75	0.5	+16.25

ELECTRICWELD STANDARD PIPE, Threaded and Coupled

Carload discounts from list, %

Youngstown Y2	+12.25	+27.25	+5.75	+22.5	+3.25	+20	+1.75	+18.5	+1.75	+18.5	+2	+18.75	0.5	+16.25

BUTTWELD STANDARD PIPE, Threaded and Coupled

Carload discounts from list, %

Size—Inches	⅛		¼		⅜		½		¾		1		1¼	
List Per Ft	5.5c		6c		6c		8.5c		11.5c		17c		23c	
Pounds Per Ft	0.24		0.42		0.57		0.85		1.13		1.68		2.28	
	Blk	Galv*	Blk	Galv*	Blk	Galv*	Blk	Galv*	Blk	Galv*	Blk	Galv*	Blk	Galv*
Aliquippa, Pa. J5	....	....	....	....	....	....	2.25	+13	5.25	+9	8.75	+4.5	11.25	+3.75
Alton, Ill. L1	....	....	....	....	....	....	0.25	+15	3.25	+11	6.75	+6.5	9.25	+5.75
Benwood, W. Va. W10	1.5	+25	+10.5	+34	+21	+42.5	2.25	+13	5.25	+9	8.75	+4.5	11.25	+3.75
Butler, Pa. F6	4.5	+22	+8.5	+32	+19.5	+41	....	....	....	....	....	....	....	....
Etna, Pa. N2	....	....	....	....	....	....	2.25	+13	5.25	+9	8.75	+4.5	11.25	+3.75
Fairless, Pa. N3	....	....	....	....	....	....	0.25	+15	3.25	+11	6.75	+6.5	9.25	+5.75
Fontana, Calif. K1	....	....	....	....	....	....	+10.75	+26	+7.75	+22	+4.25	+17.5	+1.75	+16.75
Indiana Harbor, Ind. Y1	....	....	....	....	....	....	1.25	+14	4.25	+10	7.75	+5.5	10.25	+6.25
Lorain, O. N3	....	....	....	....	....	....	2.25	+13	5.25	+9	8.75	+4.5	11.25	+3.75
Sharon, Pa. S4	4.5	+22	+8.5	+32	+19.5	+41	....	....	....	....	....	....	....	....
Sharon, Pa. M6	....	....	....	....	....	....	2.25	+13	5.25	+9	8.75	+4.5	11.25	+3.75
Sparrows Pt., Md. B2	2.5	+24	+10.5	+34	+21.5	+43	0.25	+15	3.25	+11	6.75	+6.5	9.25	+5.75
Wheatland, Pa. W9	4.5	+22	+8.5	+32	+19.5	+41	2.25	+13	5.25	+9	8.75	+4.5	11.25	+3.75
Youngstown R2, Y1	....	....	....	....	....	....	2.25	+13	5.25	+9	8.75	+4.5	11.25	+3.75

Size—Inches	1½		2		2½		3		3½		4	
List Per Ft	27.5c		37c		58.5c		76.5c		92c		$1.09	
Pounds Per Ft	2.72		3.68		5.82		7.62		9.20		10.89	
	Blk	Galv*	Blk	Galv*	Blk	Galv*	Blk	Galv*	Blk	Galv*	Blk	Galv*
Aliquippa, Pa. J5	11.75	+2.75	12.25	+2.25	13.75	+2.5	13.75	+2.5	3.25	+13.5	3.25	+13.5
Alton, Ill. L1	9.75	+4.75	10.25	+4.25	11.75	+4.5	11.75	+4.5	1.25	+15.5	1.25	+15.5
Benwood, W. Va. W10	11.75	+2.75	12.25	+2.25	13.75	+2.5	13.75	+2.5	3.25	+13.5	3.25	+13.5
Etna, Pa. N2	11.75	+2.75	12.25	+2.25	13.75	+2.5	13.75	+2.5	3.25	+13.5	3.25	+13.5
Fairless, Pa. N3	9.75	+4.75	10.25	+4.25	11.75	+4.5	11.75	+5.5	1.25	+15.5	1.25	+15.5
Fontana, Calif. K1	+1.25	+15.75	+0.75	+15.25	0.75	+15.5	0.75	+15.5	+9.75	+26.5	+9.75	+26.5
Indiana Harbor, Ind. Y1	10.75	+3.75	11.25	+3.25	12.75	+3.5	12.75	+3.5	2.25	+14.5	2.25	+14.5
Lorain, O. N3	11.75	+2.75	12.25	+2.25	13.75	+2.5	13.75	+2.5	....	....	....	....
Sharon, Pa. M6	11.75	+2.75	12.25	+2.25	13.75	+2.5	13.75	+2.5	....	....	....	....
Sparrows Pt., Md. B2	9.75	+4.75	10.25	+4.25	11.75	+4.5	11.75	+4.5	1.25	+15.5	1.25	+15.5
Wheatland, Pa. W9	11.75	+2.75	12.25	+2.25	13.75	+2.5	13.75	+2.5	3.25	+13.5	3.25	+13.5
Youngstown R2, Y1	11.75	+2.75	12.25	+2.25	13.75	+2.5	13.75	+2.5	3.25	+13.5	3.25	+13.5

*Galvanized pipe discounts based on price of zinc at 11.00c, East St. Louis.

Stainless Steel

Representative prices, cents per pound; subject to current lists of extras

AISI Type	—Rerolling— Ingot	Slabs	Forging Billets	H.R. Strip	H.R. Rods; C.F. Wire	Bars; Structural Shapes	Plates	Sheets	C.R. Strip; Flat Wire
201	22.75	25.00	....	36.00	....	43.50	39.25	48.50	45.00
202	24.75	28.25	37.75	39.00	42.25	44.50	40.00	49.25	49.25
301	24.00	26.00	38.75	37.25	43.50	46.00	41.25	51.25	47.50
302	26.25	29.50	39.50	40.50	44.25	46.75	42.25	52.00	52.00
302B	26.50	30.75	42.25	45.75	46.75	49.00	44.50	57.00	57.00
303	....	33.25	42.50	....	47.25	49.75	45.00	56.75	56.75
304	25.00	31.25	42.00	43.75	47.00	49.50	45.75	55.00	55.00
304L	....	....	49.75	51.50	54.75	57.25	53.50	62.75	62.75
305	29.50	34.75	44.00	47.50	47.00	49.50	46.25	58.75	58.75
308	32.00	36.25	49.00	50.25	54.75	57.75	55.25	63.00	63.00
309	41.25	47.50	60.00	64.50	66.25	69.50	66.00	80.50	80.50
310	51.50	59.50	81.00	84.25	89.75	94.50	87.75	96.75	96.75
314	....	....	80.50	....	89.75	94.50	87.75	....	104.25
316	41.25	47.50	64.50	68.50	71.25	75.75	71.75	80.75	80.75
316L	....	....	72.25	76.25	79.50	83.50	79.50	88.50	88.50
317	49.75	56.00	79.75	88.25	89.50	94.25	88.50	101.00	101.00
321	33.50	38.00	48.75	53.50	54.50	57.50	54.75	65.00	65.50
330	....	....	123.25	....	113.00	143.75	135.00	149.25	149.25
18-8 CbTa	38.50	48.25	57.75	63.50	63.75	67.25	64.75	79.25	79.25
403	....	....	29.25	....	33.25	35.00	30.00	40.25	40.25
405	20.25	26.50	30.75	36.00	34.75	36.50	32.50	46.75	46.75
410	17.50	19.50	29.25	31.00	33.25	35.00	30.00	40.25	40.25
416	....	....	29.75	....	33.75	35.50	31.25	48.25	48.25
420	....	31.50	35.50	41.75	40.75	42.75	40.25	62.00	62.00
430	17.75	19.75	29.75	32.00	33.75	35.50	31.00	40.75	40.75
430F	....	....	30.50	....	34.25	36.00	31.75	51.75	51.75
431	....	29.75	39.25	....	43.50	46.00	41.00	56.00	56.00
446	....	....	40.75	50.00	46.00	48.25	42.75	70.00	70.00

Producers Are: Allegheny Ludlum Steel Corp.; American Steel & Wire Div., U. S. Steel Corp.; Anchor Drawn Steel Co., division of Vanadium-Alloys Steel Co.; Armco Steel Corp.; Babcock & Wilcox Co.; Bethlehem Steel Co.; J. Bishop & Co.; A. M. Byers Co.; Calstrip Steel Corp.; G. O. Carlson Inc.; Carpenter Steel Co.; Carpenter Steel Co. of New England; Charter Wire Products; Crucible Steel Co. of America; Damascus Tube Co.; Dearborn Div., Sharon Steel Corp.; Wilbur B. Driver Co.; Driver-Harris Co.; Eastern Stainless Steel Corp.; Firth Sterling Inc.; Fort Wayne Metals Inc.; Green River Steel Corp., subsidiary of Jessop Steel Co.; Indiana Steel & Wire Co.; Ingersoll Steel Div., Borg-Warner Corp.; Ellwood Ivins Steel Tube Works Inc.; Jessop Steel Co.; Johnson Steel & Wire Co. Inc.; Stainless & Strip Div., Jones & Laughlin Steel Corp.; Joslyn Stainless Steels, division of Joslyn Mfg. & Supply Co.; Latrobe Steel Co.; Lukens Steel Co.; Maryland Fine & Specialty Wire Co. Inc.; McLouth Steel Corp.; Metal Forming Corp.; Midvale-Heppenstall Co.; National Standard Co.; National Tube Div., U. S. Steel Corp.; Pacific Tube Co.; Page Steel & Wire Div., American Chain & Cable Co. Inc.; Pittsburgh Rolling Mills Inc.; Republic Steel Corp.; Riverside-Alloy Metal Div., H. K. Porter Company Inc.; Rodney Metals Inc.; Sawhill Tubular Products Inc.; Sharon Steel Corp.; Simonds Saw & Steel Co.; Specialty Wire Co. Inc.; Standard Tube Co.; Superior Steel Div., Copperweld Steel Co.; Superior Tube Co.; Swepco Tube Corp.; Techalloy Co. Inc.; Timken Roller Bearing Co., Trent Tube Co., subsidiary of Crucible Steel Co. of America; Tube Methods Inc.; Ulbrich Stainless Steel Inc.; Union Steel Corp.; U. S. Steel Corp.; Universal Cyclops Steel Corp.; Vanadium-Alloys Steel Co.; Wall Tube & Metal Products Co.; Wallingford Steel, subsidiary, Allegheny Ludlum Steel Corp.; Washington Steel Corp.; Seymour Mfg. Co.

Clad Steel

	Plates 5%	Plates Carbon Base 10%	Plates Carbon Base 15%	Plates Carbon Base 20%	Sheets Carbon Base 20%
Stainless					
302	....	....	....	....	37.50
304	26.05	28.80	31.55	34.30	39.75
304L	30.50	33.75	36.95	40.15	....
316	38.20	42.20	46.25	50.25	58.25
316L	42.30	46.75	51.20	55.65	....
316 Cb	49.90	55.15	60.40	65.65	....
321	31.20	34.50	37.75	41.05	47.25
347	36.90	40.80	44.65	48.55	57.00
405	22.25	24.60	26.90	29.25	....
410	20.55	22.70	24.85	27.00	....
430	21.20	23.45	25.65	27.90	....
Inconel	48.90	59.55	70.15	80.55	....
Nickel	41.65	51.95	63.30	72.70	....
Nickel, Low Carbon	41.95	52.60	63.30	74.15	....
Monel	43.35	53.55	63.80	74.05	....

	Strip, Carbon Base —Cold Rolled— 10%	Both Sides
Copper*	$36.10	$43.15

*Deoxidized. Production points: Stainless-clad sheets, New Castle, Ind. I-4; stainless-clad plates, Claymont, Del. C22, Coatesville, Pa. L7, New Castle, Ind. I-4, and Washington, Pa. J3; nickel, inconel, monel-clad plates, Coatesville L7; copper-clad strip, Carnegie, Pa. S18.

Tool Steel

Grade	$ per lb	Grade	$ per lb
Reg. Carbon (W-1)	0.330	V-Cr Hot Work (H-13)	0.550
Spec. Carbon (W-1)	0.385	W-Cr Hot Work (H-12)	0.530
Oil Hardening (O-1)	0.505	W Hot Wk. (H-21)	1.425-1.44
V-Cr Hot Work (H-11)	0.505	Hi-Carbon-Cr (D-11)	0.955

Grade by Analysis (%) W	Cr	V	Co	Mo	AISI Designation	$ per lb
18	4	1	....	....	T-1	1.840
18	4	2	....	....	T-2	2.005
13.5	4	3	....	....	T-3	2.105
18.25	4.25	1	4.75	....	T-4	2.545
18	4	2	9	....	T-5	2.915
20.25	4.25	1.6	12.95	....	T-6	4.330
13.75	3.75	2	5	....	T-8	2.485
1.5	4	1	....	8.5	M-1	1.200
6.4	4.5	1.9	....	5	M-2	1.345
6	4	3	....	6	M-3	1.590

Tool steel producers include: A4, A8, B2, B8, C4, C9, C12, C18, F2, J3, L3, M14, S8, U4, V2, and V3.

Pig Iron

F.o.b. furnace prices in dollars per gross ton, as reported to STEEL. Minimum delivered prices are approximate.

	Basic	No. 2 Foundry	Malle-able	Besse-mer
Birmingham District				
Birmingham R2	62.00	62.50**	....	....
Birmingham U6	....	62.50**	66.50	....
Woodward, Ala. W15	62.00*	62.50**	66.50	....
Cincinnati, deld.	....	70.20	....	....
Buffalo District				
Buffalo H1, R2	66.00	66.50	67.00	67.50
N. Tonawanda, N.Y. T9	....	66.50	67.00	67.50
Tonawanda, N.Y. W12	66.00	66.50	67.00	67.50
Boston, deld.	77.29	77.79	78.29	....
Rochester, N.Y., deld.	69.02	69.52	70.02	....
Syracuse, N.Y., deld.	70.12	70.62	71.12	....
Chicago District				
Chicago I-3	66.00	66.50	66.50	67.00
S. Chicago, Ill. R2	66.00	66.50	66.50	67.00
S. Chicago, Ill. W14	66.00	....	66.50	67.00
Milwaukee, deld.	69.02	69.52	69.52	70.02
Muskegon, Mich., deld.	....	74.52	74.52	....
Cleveland District				
Cleveland R2, A7	66.00	66.50	66.50	67.00
Akron, Ohio, deld.	69.52	70.02	70.02	70.52
Mid-Atlantic District				
Birdsboro, Pa. B10	68.00	68.50	69.00	69.50
Chester, Pa. P4	68.00	68.50	69.00	....
Swedeland, Pa. A3	68.00	68.50	69.00	69.50
New York, deld.	....	75.50	76.00	....
Newark, N.J., deld.	72.69	73.19	73.69	74.19
Philadelphia, deld.	70.41	70.91	71.41	71.99
Troy, N.Y. R2	68.00	68.50	69.00	69.50
Pittsburgh District				
Neville Island, Pa. P6	66.00	66.50	66.50	67.00
Pittsburgh (N&S sides), Aliquippa, deld.	....	67.95	67.95	68.48
McKees Rocks, Pa., deld.	....	67.60	67.60	68.13
Lawrenceville, Homestead, Wilmerding, Monaca, Pa., deld.	....	68.26	68.26	69.79
Verona, Trafford, Pa., deld.	68.29	68.82	68.82	69.35
Brackenridge, Pa., deld.	68.60	69.10	69.10	69.63
Midland, Pa. C18	66.00	....	....	....
Youngstown District				
Hubbard, Ohio Y1	....	....	66.50	....
Sharpsville, Pa. S6	66.00	....	66.50	67.00
Youngstown Y1	....	....	66.50	....
Mansfield, Ohio, deld.	71.30	....	71.80	72.30
Duluth I-3	66.00	66.50	66.50	67.00
Erie, Pa. I-3	66.00	66.50	66.50	67.00
Everett, Mass. E1	67.50	68.00	68.50	....
Fontana, Calif. K1	75.00	75.50	....	....
Geneva, Utah C11	66.00	66.50	....	....
Granite City, Ill. G4	67.90	68.40	68.90	....
Ironton, Utah C11	66.00	66.50	....	....
Minnequa, Colo. C10	68.00	68.50	69.00	....
Rockwood, Tenn. T3	....	62.50‡	66.50	....
Toledo, Ohio I-3	66.00	66.50	66.50	67.00
Cincinnati, deld.	72.94	73.44	....	....

*Phos. 0.70-0.90%; Phos. 0.30-0.69%, $63.
**Phos. 0.70-0.90%; Phos. 0.30-0.69%, $63.50.
‡Phos. 0.50% up; Phos. 0.30-0.49%, $63.50.

PIG IRON DIFFERENTIALS

Silicon: Add 75 cents per ton for each 0.25% Si or percentage thereof over base grade, 1.75-2.25%, except on low phos. iron on which base is 1.75-2.00%.

Manganese: Add 50 cents per ton for each 0.25% manganese over 1% or portion thereof.

BLAST FURNACE SILVERY PIG IRON, Gross Ton

(Base 6.01-6.50% silicon; add 75c for each 0.50% silicon or portion thereof over the base grade within a range of 6.50 to 11.50%; starting with silicon over 11.50% add $1.50 per ton for each 0.50% silicon or portion thereof up to 14%; add $1 for each 0.50% Mn over 1%)

Jackson, Ohio I-3, J1	$78.00
Buffalo H1	79.25

ELECTRIC FURNACE SILVERY IRON, Gross Ton

(Base 14.01-14.50% silicon; add $1 for each 0.5% Si to 18%; $1.25 for each 0.50% Mn over 1%; $2 per gross ton premium for 0.045% max P)

Calvert City, Ky. P15	$99.00
Niagara Falls, N.Y. P15	99.00
Keokuk, Iowa Open-hearth & Fdry, K2	89.00
Keokuk, Iowa O.H. & Fdry, 12½ lb piglets, 16% Si, K2	92.00

LOW PHOSPHORUS PIG IRON, Gross Ton

Lyles, Tenn. T3 (Phos. 0.035% max)	$73.00
Rockwood, Tenn. T3 (Phos. 0.035% max)	73.00
Troy, N.Y. R2 (Phos. 0.035% max)	73.00
Philadelphia, deld.	81.67
Cleveland A7 (Intermediate) (Phos. 0.036-0.075% max)	71.00
Duluth I-3 (Intermediate) (Phos. 0.036-0.075%)	71.00
Erie, Pa. I-3 (Intermediate) (Phos. 0.036-0.075% max)	71.00
Neville Island, Pa. P6 (Intermediate) (Phos. 0.036-0.075% max)	71.00

Steel Service Center Products

Representative prices, per pound, subject to extras, f.o.b. warehouse. City delivery charges are 15 cents per 100 lb except: Denver, Moline, Norfolk, Richmond, Washington, 20 cents; Baltimore, Boston, Los Angeles, New York, Philadelphia, Portland, Spokane, San Francisco, 10 cents; Atlanta, Birmingham, Chattanooga, Houston, Seattle, no charge.

	SHEETS				STRIP	BARS			Standard Structural Shapes	PLATES	
	Hot-Rolled	Cold-Rolled	Galv. 10 Ga.†	Stainless Type 302	Hot-Rolled*	H.R. Rounds	C.F. Rds.‡	H.R. Alloy 4140††[8]		Carbon	Floor
Atlanta	8.59§	9.86§	10.13	....	8.91	9.39	13.24#	....	9.40	9.29	11.21
Baltimore	9.80[a]	10.00[b]	9.99	....	11.45[e]	10.05[d]	11.80#	16.38	9.55	9.90[e]	10.50
Birmingham	9.43[a]	10.20[b]	....	....	10.91[e]	9.59[d]	13.14#	16.76	9.00	9.79[e]	10.90
Boston	10.07	11.42	11.92	53.50	12.17	10.19	13.30#	15.64	10.64	10.27	11.95
Buffalo	8.40	9.60	10.85	56.98	8.75	9.15	11.45#	15.40	9.25	9.20	10.75
Chattanooga	8.35	9.69	9.65	....	8.40	8.77	10.46	....	8.88	8.80	10.66
Chicago	8.25	9.45	10.90	53.00	8.51	8.99	9.15	15.05	9.00	8.89	10.20
Cincinnati	8.43	9.51	10.95	53.43	8.83	9.31	11.58#	15.37	9.56	9.27	10.53
Cleveland	8.54[a]	8.79[b]	10.87	52.33	10.32[e]	8.75[d]	11.25#	15.16	9.39	8.71[e]	10.50[f]
Dallas	8.80	9.30	....	....	8.85	8.80	....	....	8.75	9.15	10.40
Denver	9.40	11.84	12.94	....	9.43	9.80	11.19	....	9.84	9.76	11.08
Detroit	8.51	9.71	11.25	56.50	8.88	9.30	9.51	15.33	9.56	9.26	10.46
Erie, Pa.	8.35	9.45	9.95[10]	....	8.60	9.10	11.25	....	9.35	9.10	10.60
Houston	9.65[a]	9.65[b]	....	52.00	10.85[c]	8.90[d]	13.10#	16.55	8.35	9.65[e]	10.10
Jackson, Miss.	8.52	9.79	....	....	8.84	9.82	10.68	....	9.33	9.22	11.03
Los Angeles	8.70[2]	10.82[2]	12.20	57.60	9.15	9.10[2]	12.95[2]	16.35	9.00[2]	9.10[2]	11.30[2]
Memphis, Tenn.	8.59	9.80	....	....	8.84	9.32	11.25#	....	9.33	9.22	10.86
Milwaukee	8.39	9.59	11.04	....	8.65	9.13	9.39	15.19	9.22	9.03	10.34
Moline, Ill.	8.55	9.80	....	....	8.84	8.95	9.15	....	8.99	8.91	....
New York	9.17	10.49	11.30	53.08	9.64	9.99	13.25#	15.50	9.74	9.77	11.05
Norfolk, Va.	8.65	....	....	....	9.15	9.30	12.75	....	9.65	9.10	10.50
Philadelphia	8.20	9.55	10.61	52.71	9.25	9.40	11.95#	15.48	9.10	9.15	10.40**
Pittsburgh	8.54[a]	8.79[b]	10.76	52.33	10.30[e]	8.64[d]	11.25#	15.05	9.00	8.47[e]	10.26[f]
Richmond, Va.	8.65	....	10.79	....	9.15	9.55	....	....	9.65	9.10	10.60
St. Louis	8.63	9.83	11.28	....	8.89	9.37	9.78	15.43	9.48	9.27	10.58
St. Paul	8.80[a]	9.31[b]	10.47	....	10.32[e]	8.70[d]	11.49#	16.54	9.38	8.60[e]	10.49
San Francisco	9.65	11.10	11.40	55.10	9.75	10.15	13.60	16.25	9.85	10.00	12.35
Seattle	10.30	11.55	12.50	56.52	10.25	10.50	14.70	16.80[3]	10.20	10.10	12.50
South'n, Conn.	9.07	10.33	10.71	....	9.48	9.74	....	....	9.57	9.57	10.91
Spokane	10.30	11.55	12.50	57.38	10.75	11.00	14.70	16.80	10.20	10.10	13.00
Washington	9.15	....	....	....	9.65	10.05	12.50	....	10.15	9.60	11.10

*Prices do not include gage extras; †prices include gage and coating extras; ‡includes 35-cent bar quality extras; §42 in. and under; **¼ in. and heavier; ††as annealed; ‡‡¾ in. to 4 in. wide, inclusive; #net price, 1 in. round C-1018.

[a]10 Ga.; [b]20 Ga.; [c]⅛ x 1 in.; [d]¾-2½ in.; [e]¼ x 84 in.; [f]¼ x 36.

Base quantities, 2000 to 4999 lb except as noted; cold-finished bars, 2000 lb and over except in Seattle, 2000 to 3999 lb; stainless sheets, 5000 lb except in Chicago, New York, Boston, Seattle, 10,000 lb and in San Francisco, 2000 to 4999 lb; hot-rolled products on West Coast, 2000 to 9999 lb, except in Seattle, 30,000 lb and over; [2]—30,000 lb; [3]—1000 to 4999 lb; [8]—1000 to 1999 lb; [10]—2000 lb and over.

Refractories

Fire Clay Brick (per 1000 pieces*)

High-Heat Duty: Ashland, Grahn, Hayward, Hitchens, Haldeman, Olive Hill, Ky., Athens, Troup, Tex., Beech Creek, Clearfield, Curwensville, Lock Haven, Lumber, Orviston, West Decatur, Winburne, Snow Shoe, Pa., Bessemer, Ala., Farber, Mexico, St. Louis, Vandalia, Mo., Ironton, Oak Hill, Parrail, Portsmouth, Ohio, Ottawa, Ill., Stevens Pottery, Ga., Canon City, Colo., $140; Salina, Pa., $145; Niles, Ohio, $138; Cutler, Utah, $175.

Super-Duty: Ironton, Ohio, Vandalia, Mo. Olive Hill, Ky., Clearfield, Salina, Winburne, Snow Shoe, Pa., New Savage, Md., St. Louis, $185; Stevens Pottery, Ga., $195; Cutler, Utah, $248.

Silica Brick (per 1000 pieces*)

Standard: Alexandria, Claysburg, Mt. Union, Sproul, Pa., Ensley, Ala., Pt. Matilda, Pa., Portsmouth, Ohio, Hawstone, Pa., St. Louis, $158; Warren, Niles, Windham, Ohio, Hays, Latrobe, Morrisville, Pa., $163; E. Chicago, Ind., Joliet, Rockdale, Ill., $168; Canon City, Colo., $173; Lehi, Utah, $183; Los Angeles, $185.

Super-Duty: Sproul, Hawstone, Pa., Niles, Warren, Windham, Ohio, Leslie, Md., Athens, Tex., $158; Morrisville, Hays, Latrobe, Pa., $163; E. Chicago, Ind., St. Louis, $168; Canon City, Colo., $183; Curtner, Calif., $185.

Semisilica Brick (per 1000 pieces*)

Woodbridge, N. J., Canon City, Colo., $140; Philadelphia, Clearfield, Pa. $145.

Ladle Brick (per 1000 pieces*)

Dry Pressed: Alsey, Ill., Chester, New Cumberland, W. Va., Freeport, Johnstown, Merrill Station, Vanport, Pa., Mexico, Vandalia, Mo., Wellsville, Irondale, New Salisbury, Ohio, $96.75; Clearfield, Pa., Portsmouth, Ohio, $102.

High-Alumina Brick (per 1000 pieces*)

50 *Per Cent:* St. Louis, Mexico, Vandalia, Mo., Danville, Ill., $253; Philadelphia, $265; Clearfield, Pa., $230; Orviston, Snow Shoe, Pa., $260.

60 *Per Cent:* St. Louis, Mexico, Vandalia, Mo., $310; Danville, Ill., $313; Clearfield, Orviston, Snow Shoe, Pa., $320; Philadelphia, $325.

70 *Per Cent:* St. Louis, Mexico, Vandalia, Mo., $350; Danville, Ill., $353; Clearfield, Orviston, Snow Shoe, Pa., $360; Philadelphia, $365.

Sleeves (per 1000)

Reesdale, Johnstown, Bridgeburg, St. Charles, Pa., St. Louis, $188; Ottawa, Ill., $205.

Nozzles (per 1000)

Reesdale, Johnstown, Bridgeburg, St. Charles, Pa., St. Louis, $310.

Runners (per 1000)

Reesdale, Johnstown, Bridgeburg, St. Charles, Pa., $234.

Dolomite (per net ton)

Domestic, dead-burned, bulk, Billmeyer, Blue Bell, Williams, Plymouth Meeting, York, Pa., Millville, W. Va., Bettsville, Millersville, Martin, Woodville, Gibsonburg, Narlo, Ohio, $16.75; Thornton, McCook, Ill., $17; Dolly Siding, Bonne Terre, Mo., $15.60.

Magnesite (per net ton)

Domestic, dead-burned, ½ in. grains with fines: Chewelah, Wash., Luning, Nev., $46; ⅝ in. grains with fines: Baltimore, $73.

*—9 in. x 4½ x 2.50 sts.

Fluorspar

Metallurgical grades, f.o.b. shipping point in Ill., Ky., net tons, carloads, effective CaF_2 content 72.5%, $37-$41; 70%, $36-$40; 60%, $33-$36.50. Imported, net ton, f.o.b. cars point of entry, duty paid, metallurgical grade; European, $30-$33, contract; Mexican, all rail, duty paid, $26.50-$27; barge, Brownsville, Tex., $29-$29.50.

Electrodes

Threaded with nipple; unboxed, f.o.b. plant

GRAPHITE

Inches Diam	Inches Length	Per 100 lb
2	24	$64.00
2½	30	41.50
3	40	39.25
4	40	37.00
5½	40	36.50
6	60	33.25
7	60	29.75
8, 9, 10	60	29.50
12	72	28.25
14	60	28.25
16	72	27.25
17	60	27.25
18	72	27.00
20	72	26.50
24	84	27.25

CARBON

8	60	14.25
10	60	13.80
12	60	14.75
14	60	14.75
14	72	12.55
17	60	12.65
17	72	12.10
20	90	11.55
24	72, 84	11.95
24	96	12.10
30	84	12.00
35, 40	110	11.60
40	100	12.50

Metal Powder

(Per pound, f.o.b. shipping point in ton lots for minus 100 mesh, except as noted)

	Cents
Sponge Iron, domestic and foreign, 98% Fe, min. trucklots, freight allowed east of Mississippi River:	
100 mesh, bags	11.25
100 mesh, pails	9.10‡
40 mesh, bags	8.10††
Electrolytic Iron, Melting stock, 99.87% Fe, irreg. fragments, ⅛ in. x 1.3 in.	28.75
1.3 in.	28.75
(In contract lots of 240 tons price is 22.75c)	
Annealed, 99.5% Fe.	36.50
Unannealed (99+% Fe)	36.00
Unannealed (99+% Fe) (minus 325 mesh)	59.00
Powder Flake (minus 16 plus 100 mesh).	29.00
Carbonyl Iron: 98.1-98.9%, 3 to 20 microns, depending on grade, 93.00-290.00 in standard 200-lb containers; all minus 200 mesh.	
Aluminum: Atomized, 500-lb drum, freight allowed, c.l. 38.50; ton lots 40.50	
Antimony, 500-lb lots	42.00*
Brass, 5000-lb lots	34.20-50.70†
Bronze, 5000-lb lots	52.10-56.10†
Copper, electrolytic	14.25*
Copper, reduced	14.25*
Lead	7.50*
Manganese, Electrolytic: Minus 50 mesh	43.00
Nickel	80.60
Nickel-Silver, 5000-lb lots	52.70-57.10†
Phosphor-Copper, 5000-lb lots	64.50
Copper (atomized) 5000-lb lots	45.00-53.50
Solder	7.00*
Stainless Steel, 304	$0.89
Stainless Steel, 316	$1.07
Tin	14.00*
Zinc, 5000-lb lots	19.20-32.40‡
Tungsten: Carbon reduced, 98.8% min, minus 65 mesh	Dollars nom**
Chromium electrolytic 99.8% Cr, min. metallic basis	5.00

*Plus cost of metal. †Depending on composition. ‡Depending on mesh. §Cutting and scarfing grade. **Depending on price of ore. ††Welding grade.

Ores

Lake Superior Iron Ore

(Prices effective at start of the 1959 shipping season, subject to later revision, gross ton, 51.50% iron natural, rail of vessel, lower lake ports.)

Mesabi bessemer	$11.60
Mesabi nonbessemer	11.45
Old Range bessemer	11.85
Old Range nonbessemer	11.70
Open-hearth lump	12.70
High phos	11.45

The foregoing prices are based on upper lake rail freight rates, lake vessel freight rates, handling and unloading charges, and taxes thereon, which were in effect Jan. 1, 1959, and increases or decreases after that date are absorbed by the seller.

Eastern Local Iron Ore

Cents per unit, deld. E. Pa.

New Jersey, concentrates ..... nom.

Foreign Iron Ore

Cents per unit, c.i.f. Atlantic ports

Swedish basic, 65%	21.00†
Brazilian iron ore, 68.5%	22.60

Tungsten Ore

Net ton, unit

Foreign wolframite, good commercial quality	$16-$17†
Domestic, concentrates f.o.b. milling points	16.00-17.00†

*Before duty. †Nominal.

Manganese Ore

Mn 46-48%, Indian 88.5-91.5c, nom. per long to unit, c.i.f. U. S. ports, duty for buyer's account.

Chrome Ore

Gross ton, f.o.b. cars New York, Philadelphia, Baltimore, Charleston, S. C., plus ocean freight differential for delivery to Portland, Oreg., Tacoma, Wash.

Indian and Rhodesian

48% 3:1	$42.00-44.00†
48% 2:8:1	38.00-40.00†
48% no ratio	29.00-31.00†

South African Transvaal

44% no ratio	19.75-21.00
48% no ratio	29.00-31.00

Turkish

48% 3:1	51.00-55.00†

Domestic

Rail nearest seller

18% 3:1	30.00

Molybdenum

Sulfide concentrate, per lb of Mo content, mines, unpacked $1.23

Antimony Ore

Per short ton unit of Sb content, c.i.f. seaboard

50-55%	$2.25-2.40
60-65%	2.50-3.10

Vanadium Ore

Cents per lb V_2O_5

Domestic	31.00

†Nominal.

Metallurgical Coke

Price per net ton

Beehive Ovens

Connellsville, Pa., furnace	$14.75-15.25
Connellsville, Pa., foundry	18.00-18.50

Oven foundry Coke

Birmingham, oven	$30.35
Cincinnati, deld.	33.34
Buffalo, ovens	32.00
Detroit, ovens	32.00
Pontiac, Mich., deld.	33.95
Saginaw, Mich., deld.	35.53
Erie, Pa., ovens	32.00
Everett, Mass., ovens:	
New England, deld.	33.55*
Indianapolis, ovens	31.25
Ironton, Ohio, ovens	30.50
Cincinnati, deld.	33.54
Kearny, N. J., ovens	31.25
Milwaukee, ovens	32.00
Neville Island (Pittsburgh), Pa., ovens	30.75
Painesville, Ohio, ovens	32.00
Cleveland, deld.	34.19
Philadelphia, ovens	31.00
St. Louis, ovens	33.00
St. Paul, ovens	31.25
Chicago, deld.	34.68
Swedeland, Pa., ovens	31.00
Terre Haute, Ind., ovens	31.25

*Within $5.15 freight zone from works.

Imported Steel

(Base per 100 lb, landed, duty paid; based on current ocean rates with any rise for buyer's acc't. Source of shipment: Western Europe)

	North Atlantic	Great Lakes*	South Atlantic	Gulf Coast	West Coast
Deformed Bars, Intermediate, ASTM-A 305	$6.18	....	$6.13	$6.04	$6.41
Bar Size Angles	6.18	....	6.13	6.04	6.41
Structurals Angles	6.03	....	5.98	5.88	6.28
I-Beams	6.03	....	5.98	5.88	6.28
Channels	6.03	....	5.98	5.88	6.28
Plates (basic bessemer)	5.95	....	5.90	5.80	6.20
Sheets, H.R.	9.00	....	8.95	8.85	9.25
Sheets, Galvanized, 20 Ga., 36 in. x 96 in.	9.90	....	9.85	9.75	10.25
Sheets, Galv. (in coils) 20 Ga., 48 in. wide	10.05	....	10.00	9.90	10.30
Sheets, C.R. (drawing quality)	10.00	....	10.95	10.85	11.25
Furring Channels, C.R., 1000 ft, ⅞ x 0.30 lb per ft	25.50	....	25.28	24.99	26.68
Barbed Wire (†)	8.00	....	7.95	7.85	8.25
Merchant Bars	6.18	....	6.13	6.04	6.41
Hot-Rolled Bands	8.90	....	8.85	8.75	9.15
Wire Rods, Thomas Commercial No. 5	6.40	....	6.40	6.25	6.60
Wire Rods, O.H.	6.90	....	6.90	6.75	7.10
Bright Common Wire Nails (‡)	8.40	....	8.45	8.35	8.75

*Books closed for 1959-60 shipping season. †Per 82 lb net reel. ‡Per 100-kegs, 20d nails and heavier.

Coal Chemicals

(Representative prices)

Cents per gal f.o.b. tank cars or tank trucks, plant.

Pure benzene	31.00
Xylene, industrial grade	29.00
Creosote	24.00
Naphthalene, 78 deg	5.00
Toluene one deg (deld. east of Rockies)	25.00

Cents per lb, f.o.b. tank cars or tank trucks, deld.

Phenol, 90 per cent grade	14.75

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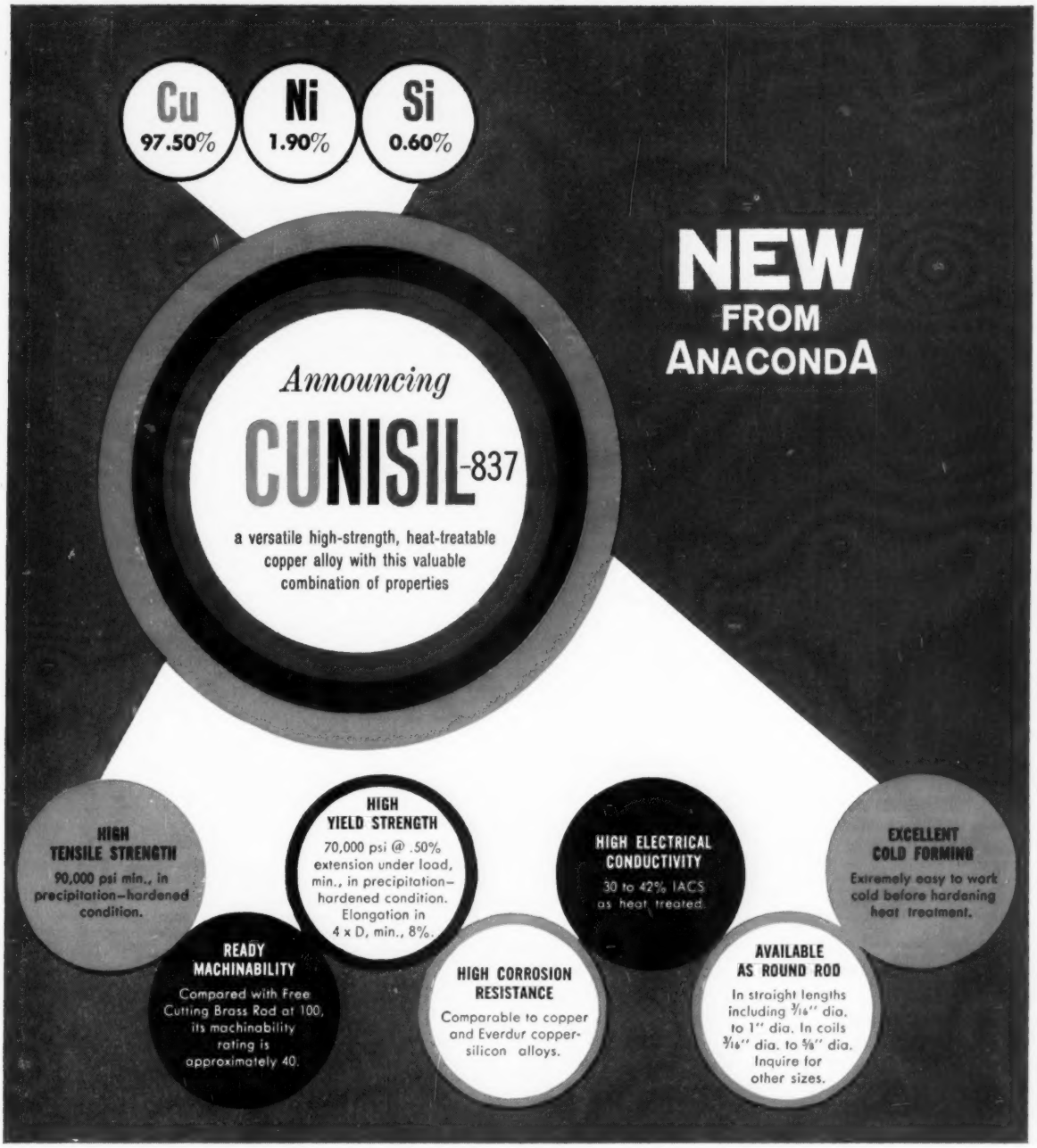
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Prior to the hardening heat treatment, the alloy is brought to a proper condition for hardening by giving it a solution anneal at a much higher temperature and then a quenching from this temperature; at this stage the alloy is quite soft and in a condition for drastic cold-working operations. The hardening heat treatment consists of heating at a controlled temperature for a definite length of time to obtain the desired mechanical properties.

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Standard Ferromanganese: (Mn 74-76%, C 7% approx) base price per net ton, $245, Johnstown, Duquesne, Sheridan, Neville Island, Pa.; Alloy, W. Va.; Ashtabula, Marietta, O.; Sheffield, Ala.; Portland, Oreg. Add or subtract $2 for each 1% or fraction thereof of contained manganese over 76% or under 74%, respectively (Mn 79-81%). Lump $253 per net ton, f.o.b. Anaconda or Great Falls, Mont. Add $2.60 for each 1% above 81%; subtract $2.60 for each 1% below 79%, fractions in proportion to nearest 0.1%.

High-Grade Low-Carbon Ferromanganese: (Mn 85-95). Carload, lump, bulk, max 0.07% C, 35.1c per lb of contained Mn, carload packed 36.4c, ton lots 37.9c, less ton 39.1c. Delivered. Deduct 1.5c for max 0.15% C grade from above prices, 3c for max 0.03% C, 3.5c for max 0.5% C, and 6.5c for max 75% C—max 7% Si. **Special Grade:** (Mn 90% min, C 0.07% max, P 0.06% max). Add 2.05c to the above prices. Spot, add 0.25c.

Medium-Carbon Ferromanganese: (Mn 80-85%, C 1.25-1.5%, Si 1.5% max). Carload, lump, bulk, 25.5c per lb of contained Mn; packed, carload 26.8c, ton lot 28.4c, less ton 29.6c.

Electrolytic Manganese Metal: Min carload, bulk, 33.25c; 2000 lb to min carload 36c; less ton, 38c; 50 lb cans, add 0.5c per lb. Premium for hydrogen-removed metal 0.75c per lb. Prices are f.o.b. cars, Knoxville, Tenn., freight allowed to St. Louis or any point east of Mississippi River; or f.o.b. Marietta, O., freight allowed.

Silicomanganese: (Mn 65-68%). Carload, lump, bulk, 1.50% C grade, 18.5-21% Si, 12.8c per lb of alloy. Packed, c.l. 14c, ton 14.45c, less ton 15.45c, f.o.b. Alloy, W. Va.; Ashtabula, Marietta, O.; Sheffield, Ala.; Portland, Oreg. For 2% C grade, Si 16-18.5%, deduct 0.2c from above prices. For 3% grade, Si 12.5-16%, deduct 0.4c from above prices. Spot, add 0.25c.

TITANIUM ALLOYS

Ferrotitanium, Low-Carbon: (Ti 20-25%, Al 3.5% max, Si 4% max, C 0.10% max). Contract, ton lot, 2" x D, $1.50 per lb of contained Ti; less ton to 300 lb, $1.55. (Ti 38-43%, Al 8% max, Si 4% max, C 0.10% max). Ton lot $1.35, less ton to 300 lb $1.37, f.o.b. Niagara Falls, N. Y., freight allowed to St. Louis.

Ferrotitanium, High-Carbon: (Ti 15-18%, C 6-8%). Contract min c.l. $250 per ton, f.o.b. Niagara Falls, N. Y., freight allowed to destinations east of Mississippi River and north of Baltimore and St. Louis. Spot, $255.

Ferrotitanium, Medium-Carbon: (Ti 17-21%, C 2-4%). Contract, c.l. $300 per ton, f.o.b. Niagara Falls, N. Y., freight not exceeding St. Louis rate allowed. Spot, $305.

CHROMIUM ALLOYS

High-Carbon Ferrochrome: C.l. lump, bulk, 28.75c per lb of contained Cr. Delivered.

Charge Chrome 1: Cr 63%, C 6% max, Si 7% max 22c. **Charge Chrome 2:** Cr 50-59%, C 8% max, Si 6% max, 23c. Carload, lump, bulk, per lb Cr.

Refined Chrome 1: Cr 50-59%, C 5% max, Si 2% max, 25c. **Refined Chrome 2:** Si 12% max, 24c. Carload, lump, bulk, per lb Cr.

Low-Carbon Ferrochrome: Cr 63-66% (Simplex), carload, lump, bulk, C 0.025% max, 36.75c per lb contained Cr; 0.010% max, 37.75c. Delivered.

Cr 67-71%, carload, lump, bulk, 0.025% max, 39.75c; 0.05% max, 39.00c; 0.10% max, 38.50c; 0.20% max, 38.25c; 0.50% max, 38.00c; 1.0% max, 37.75c; 1.5% max, 37.50c; 2.0% max, 37.25c. Delivered.

Foundry Ferrochrome, High-Carbon: (Cr 62-66%, C 5-7%, Si 7-10%). C.l., 2" x D, bulk 30.8c per lb of contained Cr. Packed, c.l. 32.4c, ton 34.2c, less ton 35.7c. Delivered. Spot, add 0.25c.

Foundry Ferrosilicon Chrome: (Cr 50-54%, Si 28-32%, C 1.25% max). 8M x D, carload, bulk, 20.05c per lb of alloy, carload packed, 21.25c, ton lot 22.50c, less ton lot 23.70c. Delivered. Spot, add 0.25c.

Ferrochrome-Silicon: Cr 39-41%, Si 42-45%, C 0.05% max or Cr 33-36%, Si 45-48%, C 0.05% max. Carload, lump, bulk, 3" x down and 2" x down, 28.25c per lb contained Cr, 14.60c per lb contained Si, 0.75" x down 29.40c per lb contained Cr, 14.60c per lb contained Si.

Chromium Metal, Electrolytic: Commercial grade (Cr 99.8% min, metallic basis, Fe 0.2% max). Contract, carlot, packed, 2" x D plate (about ⅛" thick) $1.15 per lb, ton lot $1.17, less ton lot $1.19. Delivered. Spot, add 5c.

VANADIUM ALLOYS

Ferrovanadium: Open hearth grade (V 50-55%, Si 8% max, C 3% max). Contract, any quantity, $3.20 per lb of contained V. Delivered. Spot, add 10c. **Special Grade:** (V 50-55% or 70-75%, Si 2% max, C 0.5% max) $3.30. **High Speed Grade:** (V 50-55% or 70-75%, Si 1.50% max, C 0.20% max) $3.40.

Grainal: Vanadium Grainal No. 1 $1.05 per lb; No. 79, 50c, freight allowed.

Vanadium Oxide: Contract, less carload lot, packed, $1.38 per lb contained V_2O_5, freight allowed. Spot, add 5c.

SILICON ALLOYS

50% Ferrosilicon: Carload, lump, bulk, 14.6c per lb contained Si. Packed, c.l. 17.1c, ton lot 18.55c, less ton 20.20c, f.o.b. Alloy, W. Va.; Ashtabula, Marietta, O.; Sheffield, Ala.; Keokuk, Iowa; Portland, Oreg. Spot, add 0.45c.

Low-Aluminum 50% Ferrosilicon: (Al 0.40% max). Add 1.45c to 50% ferrosilicon prices.

65% Ferrosilicon: Carload, lump, bulk, 15.75c per lb contained silicon. Packed, c.l. 17.75c, ton lot 19.55c, less ton 20.9c. Delivered. Spot, add 0.35c.

75% Ferrosilicon: Carload, lump, bulk, 16.9c per lb of contained Si. Packed, c.l. 18.8c, ton lot 20.45c, less ton 21.7c. Delivered. Spot add 0.3c.

90% Ferrosilicon: Carload, lump, bulk, 20c per lb of contained Si. Packed, c.l. 21.65c, ton lot 23.05c, less ton 24.1c. Delivered. Spot, add 0.25c.

Silicon Metal: (98% min Si, 1.00% max Fe, 0.07% max Ca). C.l. lump, bulk, 21.5c per lb of Si. Packed, c.l. 23.15c, ton lot 24.45c, less ton 25.45c. Add 0.5c for max 0.03% Ca grade. Add 0.5c for 0.50% Fe grade analyzing 98.25% min Si.

Alsifer: (Approx 20% Al, 40% Si, 40% Fe). Contract, basis f.o.b. Niagara Falls, N. Y., lump, carload, bulk, 9.85c per lb of alloy; ton lot, packed, 10.85c.

ZIRCONIUM ALLOYS

12-15% Zirconium Alloy: (Zr 12-15%, Si 39-43%, C 0.20% max). Contract, c.l., lump, bulk, 9.25c per lb of alloy. Packed, c.l. 10.45c, ton lot 11.6c, less ton 12.45c. Delivered. Spot, add 0.25c.

35-40% Zirconium Alloy: (Zr 35-40%, Si 47-52%, Fe 8-12%, C 0.50% max). Carload, bulk 26.25c per lb of alloy, carload, lump, packed 27.25c, ton lot 28.4c, less ton 29.65c. Freight allowed. Spot, add 0.25c.

BORON ALLOYS

Ferroboron: 100 lb or more packed (B 17.50% min, Si 1.50% max, Al 0.50% max, C 0.50% max). Contract, 100 lb or more 1" x D, $1.20 per lb of alloy; less than 100 lb $1.30. Delivered. Spot, add 5c. F.o.b. Washington, Pa., prices, 100 lb and over are as follows: Grade A (10-14% B) 85c per lb; Grade B (14-18% B) $1.20; Grade C (19% min B) $1.50.

Borosil: (3 to 4% B, 40 to 45% Si). Carload, bulk, lump, or 3" x D, $5.25 per lb of contained B. Packed, carload $5.40, ton to c.l. $5.50, less ton $5.60. Delivered.

Carbortam: (B 1 to 2%). Lump, carload $320 per ton, f.o.b. Suspension Bridge, N.Y., freight allowed same as high-carbon ferrotitanium.

CALCIUM ALLOYS

Calcium-Manganese-Silicon: (Ca 16-20%, Mn 14-18% and Si 53-59%). Carload, lump, bulk 23c per lb of alloy, carload packed 24.25c, ton lot 26.15c, less ton 27.15c. Delivered. Spot, add 0.25c.

Calcium-Silicon: (Ca 30-33%, Si 60-65%, Fe 1.5-3%). Carload, lump, bulk 24c per lb of alloy, carload packed 25.65c, ton lot 27.95c, less ton 29.45c. Delivered. Spot, add 0.25c.

BRIQUETTED ALLOYS

Chromium Briquets: (Weighing approx 3¾ lb each and containing 2 lb of Cr). Carload, bulk 19.60c per lb of briquet, in bags 20.70c; 3000 lb to c.l. pallets 20.80c; 2000 lb to c.l. in bags 21.90c; less than 2000 lb in bags 22.80c. Delivered. Add 0.25c for notching. Spot, add 0.25c.

Ferromanganese Briquets: (Weighing approx 3 lb and containing 2 lb of Mn). Carload, bulk 14.8c per lb of briquet; c.l., packed, bags 16c; 3000 lb to c.l., pallets 16c; 2000 lb to c.l., bags 17.2; less ton 18.1c. Delivered. Add 0.25c for notching. Spot, add 0.25c.

Silicomanganese Briquets: (Weighing approx 3½ lb and containing 2 lb of Mn and approx ½ lb of Si). C.l. bulk 15.1c per lb of briquet; c.l. packed, bags 16.3c, 3000 lb to c.l., pallets 16.3c; 2000 lb to c.l., bags 17.5c; less ton 18.4c. Delivered. Add 0.25c for notching. Spot, add 0.25c.

Silicon Briquets: (Large size—weighing approx 5 lb and containing 2 lb of Si and small sizes, weighing approx 2½ lb and containing 1 lb of Si). Carload, bulk 8c per lb of briquet; packed, bags 9.2c; 3000 lb to c.l., pallets 9.6c; 2000 lb to c.l.; bags 10.8c; less ton 11.7c. Delivered. Spot, add 0.25c.

Molybdic-Oxide Briquets: (Containing 2½ lb of Mo each). $1.49 per lb of Mo contained, f.o.b. Langeloth, Pa.

Titanium Briquets: Ti 98.27%, $1 per lb f.o.b. Niagara Falls, N. Y.

TUNGSTEN ALLOYS

Ferrotungsten: (70-80%). 5000 lb W or more $2.15 per lb (nominal) of contained W. Delivered.

OTHER FERROALLOYS

Ferrocolumbium: (Cb 50-60%, Si 8% max, C 0.1% max). Ton lots 2" x D, $3.45 per lb of contained Cb; less ton lots $3.50 (nominal). Delivered.

Ferrotantalum Columbium: (Cb 40% approx, Ta 20% approx, and Cb plus Ta 60% min, C 0.30% max). Ton lots 2" x D, $3.05 per lb of contained Cb plus Ta, delivered; less ton lots $3.10.

SMZ Alloy: (Si 60-65%, Mn 5-7%, Zr 5-7%, Fe 20% approx). Carlot bulk 19.25c per lb of alloy, c.l. packed ½ in. x 12 M 20.00c, ton lot 21.15c, less ton 22.40c. Delivered. Spot, add 0.25c.

Graphidox No. 4: (Si 48-52%, Ca 5-7%, Ti 9-11%). C.l. packed, 20c per lb of alloy, ton lot 21.15c; less ton lot 22.4c, f.o.b. Niagara Falls, N. Y., freight allowed to St. Louis.

V-5 Foundry Alloy: (Cr 38-42%, Si 17-19%, Mn 8-11%). C.l. packed 18.45c per lb of alloy; ton lot 19.95c; less ton lot 21.20c, f.o.b. Niagara Falls, N. Y., freight allowed to St. Louis.

Simanal: (Approx 20% each Si, Mn, Al; bal Fe). Lump, carload, bulk 19.25c. Packed c.l. 20.25c, 2000 lb to c.l. 21.25c; less than 2000 lb 21.75c per lb of alloy. Delivered.

Ferrophosphorus: (23-25% based on 24% P content with unitage of $5 for each 1% of P above or below the base). Carload, bulk, f.o.b. sellers' works, Mt. Pleasant, Siglo, Tenn., $120 per gross ton.

Ferromolybdenum: (55-75%). Per lb of contained Mo in 200-lb container, f.o.b. Langeloth and Washington, Pa., $1.76 in all sizes except powdered which is $1.82.

Technical Molybdic-Oxide: Per lb of contained Mo, in cans, $1.47; in bags, $1.46, f.o.b. Langeloth and Washington, Pa.

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W 3

Scrap Poised for Another Spurt

STEEL's composite on No. 1 heavy melting grade is unchanged at $44.33, but dealers think a sharp rise will immediately follow resumption of steelmaking operations

Scrap Prices, Page 254

• **Chicago** — There is a stronger tone in the market, but it will take a few days to determine to what extent prices will be influenced by the resumption of steelmaking operations. It's not likely that the mills will rush to buy scrap because they had generous inventories when the plants were struck.

• **New York** — Brokers' buying prices have been advanced $1 a ton on machine shop turnings, mixed borings and turnings, and short shoveling turnings. Heavy breakable cast is also up $1.

• **Philadelphia** — Strength dominates the market. Export demand is active—35,000 to 40,000 tons will probably leave this port this month for Japan.

• **Pittsburgh** — The Pennsylvania Railroad got substantially higher prices for its scrap this month. Its No. 1 heavy melting jumped $4 to $49.10. Rail crops under 18 in. brought $66 (vs. $61 last month). Some consumers are reportedly offering $49.50 for No. 1 busheling —because it might be used in lieu of low phos material, virtually unobtainable locally. District mills are undecided about their scrap purchase plans.

• **Cleveland**—Higher scrap prices are expected over coming weeks in step with rising steelmaking operations. Recently quoted prices have been largely nominal since there has been too little buying to provide a thorough test, but some dealers think No. 1 heavy melting will command at least $1 a ton above the quoted range of $41-$42 when it begins to move. Dealers' stocks are large, but the volume of industrial scrap is shrinking as manufacturing plants suspend for lack of steel.

• **Youngstown**—Market bullishness stems from expectations of an active winter demand for scrap due to probable iron ore shortages. Brokers are reported bidding higher prices for dealer tonnage, but there have been no recent purchases by consumers.

• **Detroit**—Prices are unchanged as dealers and brokers disagree on what will happen when the mills get into full production. Brokers feel the steelmakers will be using more plant scrap and that prices won't move up to much initially.

• **Buffalo**—Local dealers are talking in terms of a $3 to $5 a ton boost in prices on the primary grades of steelmaking scrap.

• **Cincinnati**—Brokers raised prices $1 a ton on most grades of scrap last week, and the market continues

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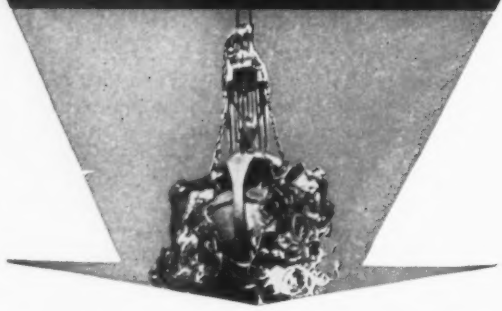

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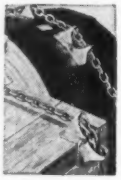

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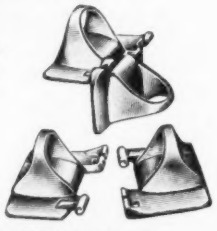

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bullish on expectations of active mill buying once idled steelmaking furnaces resume operation. Brokers now quote No. 1 heavy melting at $37.50-$38.50, and bidding is showing increased speculative activity. Industrial scrap generation is expected to dry up as steel shortages put a crimp in manufacturing.

• **Birmingham** — Some foundries have been stockpiling material as a hedge against an expected price increase over coming weeks. Resumption of steelmaking operations is expected to spark a sharp rise in prices.

Changes Are Proposed in Scrap Classifications

Approval of a proposed revision of Simplified Practice Recommendation R58-36, Classification of Iron and Steel Scrap, is being sought by the Commodity Standards Division, U. S. Department of Commerce. The proposal is being circulated among scrap sources, processors, and users.

The proposed revision, requested by the Institute of Scrap Iron & Steel Inc. to modernize the classification structure, and reflect present industry practices, reduces the number of grades to four, comprising 40 classifications.

Certain classifications are new, including two under the basic open hearth and blast furnace grade which recognize that the large hydraulic presses now used in scrapyards bundle complete automobiles, and include both heavy and light grades of steel.

Luria and Scrap Institute Deny Antitrust Charges

Investigation by the Justice Department of Luria Bros. Inc. (for possible prosecution under the Sherman Act) and the Institute of Scrap Iron & Steel Inc. (for possible violation of the antitrust laws) was called for last week in a majority report on the scrap industry by the Senate Small Business Committee, headed by Sen. John Sparkman (Dem., Ala.).

Sen. Jacob K. Javits (R., N. Y.), a committee member, concurred generally with the majority report in a separate statement, but another committee member, Sen. Andrew F. Schoeppel (R., Kans.), dissented from the majority report, holding the charges were unsupported by the evidence.

Sen. Russell B. Long (Dem., Ala.), chairman of the committee's subcommittee on monopoly, said the major problem of the scrap industry is the increasing concentration and control of the industry by Luria Bros. and domination of the Scrap Institute by Luria.

Replying to the charges, Ralph Ablon, Luria's president, said the committee report is largely a restatement of the same charges involved in the Luria case long pending before the Federal Trade Commission. He denied that Luria dominates the institute, pointing out that the policies of that organization are determined by a board of directors on which no company has more than one vote.

Edwin C. Barringer, executive vice president of the institute, said the setup of the organization precludes its domination by one member as charged in the Senate report. Each of the 25 chapter presidents, with 13 directors at large elected at the national conventions, make up a board of 38 which elects the national officers, determines policy, and conducts the business of the institute.

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Iron and Steel Scrap

Consumer prices per gross ton, except as otherwise noted, including broker's commission, as reported to STEEL, Oct. 21, 1959. *Changes shown in italics.*

STEELMAKING SCRAP COMPOSITE

Oct. 21	$44.33
Oct. 14	44.33
Sept. Avg.	41.25
Oct. 1958	42.25
Oct. 1954	32.25

Based on No. 1 heavy melting grade at Pittsburgh, Chicago, and eastern Pennsylvania.

PITTSBURGH

No. 1 heavy melting	44.00-45.00
No. 2 heavy melting	35.00-36.00
No. 1 dealer bundles	45.00-46.00
No. 2 bundles	31.00-32.00
No. 1 busheling	44.00-45.00
No. 1 factory bundles	*53.00-54.00*
Machine shop turnings	22.00-23.00
Mixed borings, turnings	22.00-23.00
Short shovel turnings	29.00-30.00
Cast iron borings	29.00-30.00
Cut structurals:	
2 ft and under	51.00-52.00
3 ft and under	50.00-51.00
Heavy turnings	35.00-36.00
Punchings & plate scrap	52.00-53.00
Electric furnace bundles	*53.00-54.00*

Cast Iron Grades

No. 1 cupola	48.00-49.00
Stove plate	46.00-47.00
Unstripped motor blocks	34.00-35.00
Clean auto cast	47.00-48.00
Drop broken machinery	53.00-54.00

Railroad Scrap

No. 1 R.R. heavy melt.	*49.00-50.00*
Rails, 2 ft and under	*65.00-66.00*
Rails, 18 in. and under	*66.00-67.00*
Random rails	*60.00-61.00*
Angles, splice bars	*59.00-60.00*
Railroad specialties	*59.00-60.00*
Rails, rerolling	65.00-66.00

Stainless Steel Scrap

18-8 bundles & solids	230.00-235.00
18-8 turnings	115.00-120.00
430 bundles & solids	125.00-130.00
430 turnings	55.00-65.00

CHICAGO

No. 1 hvy melt., indus.	44.00-45.00
No. 1 hvy melt., dealer	42.00-43.00
No. 2 hvy melting	39.00-40.00
No. 1 factory bundles	48.00-49.00
No. 1 dealer bundles	42.00-43.00
No. 2 bundles	29.00-30.00
No. 1 busheling, indus.	44.00-45.00
No. 1 busheling, dealer	42.00-43.00
Machine shop turnings	23.00-24.00
Mixed borings, turnings	26.00-27.00
Short shovel turnings	26.00-27.00
Cast iron borings	26.00-27.00
Cut structurals, 3 ft	50.00-51.00
Punchings & plate scrap	52.00-53.00

Cast Iron Grades

No. 1 cupola	57.00-58.00
Stove plate	52.00-53.00
Unstripped motor blocks	48.00-49.00
Clean auto cast	63.00-64.00
Drop broken machinery	63.00-64.00

Railroad Scrap

No. 1 R.R. heavy melt.	48.00-49.00
R.R. malleable	65.00-66.00
Rails, 2 ft and under	63.00-64.00
Rails, 18 in. and under	64.00-65.00
Angles, splice bars	57.00-58.00
Axles	57.00-58.00
Rails, rerolling	64.00-65.00

Stainless Steel Scrap

18-8 bundles, solids	215.00-220.00
18-8 turnings	115.00-120.00
430 bundles & solids	115.00-120.00
430 turnings	55.00-60.00

YOUNGSTOWN

No. 1 heavy melting	44.00-45.00
No. 2 heavy melting	28.00-29.00
No. 1 busheling	46.00-47.00
No. 1 bundles	46.00-47.00
No. 2 bundles	28.00-29.00
Machine shop turnings	18.00-19.00
Short shovel turnings	23.00-24.00
Cast iron borings	23.00-24.00
Low phos.	47.00-48.00
Electric furnace bundles	47.00-48.00

Railroad Scrap

No. 1 R.R. heavy melt.	46.00-47.00

CLEVELAND

No. 1 heavy melting	41.00-42.00
No. 2 heavy melting	28.00-29.00
No. 1 factory bundles	46.00-47.00
No. 1 bundles	42.00-43.00
No. 2 bundles	26.00-27.00
No. 1 busheling	42.00-43.00
Machine shop turnings	15.00-16.00
Short shovel turnings	21.00-22.00
Mixed borings, turnings	21.00-22.00
Cast iron borings	21.00-22.00
Cut foundry steel	41.00-42.00
Cut structurals, plate 2 ft and under	51.00-52.00
Low phos. punchings & plate	43.00-44.00
Alloy free, short shovel turnings	23.00-24.00
Electric furnace bundles	43.00-44.00

Cast Iron Grades

No. 1 cupola	55.00-56.00
Charging box cast	41.00-42.00
Heavy breakable cast	41.00-42.00
Stove plate	47.00-48.00
Unstripped motor blocks	39.00-40.00
Brake shoes	39.00-40.00
Clean auto cast	58.00-59.00
Burnt cast	40.00-41.00
Drop broken machinery	55.00-56.00

Railroad Scrap

R.R. malleable	66.00-67.00
Rails, 2 ft and under	61.00-62.00
Rails, 18 in. and under	62.00-63.00
Rails, random lengths	55.00-56.00
Cast steel	49.00-50.00
No. 1 railroad cast	58.50-59.50
Railroad specialties	55.00-56.00
Angles, splice bars	55.00-56.00
Rails, rerolling	70.00-71.00

Stainless Steel

(Brokers' buying prices: f.o.b. shipping point)

18-8 bundles, solids	215.00-220.00
18-8 turnings	110.00-115.00
430 clips, bundles, solids	125.00-130.00
430 turnings	45.00-55.00

ST. LOUIS

(Brokers' buying prices)

No. 1 heavy melting	*39.00*
No. 2 heavy melting	*37.00*
No. 1 bundles	43.00
No. 2 bundles	26.00
No. 1 busheling	43.00
Machine shop turnings	19.00
Short shovel turnings	21.00

Cast Iron Grades

No. 1 cupola	54.00
Charging box cast	45.00
Heavy breakable cast	44.00
Unstripped motor blocks	44.00
Clean auto cast	56.00
Stove plate	45.00

Railroad Scrap

No. 1 R.R heavy melt.	49.00
Rails, 18 in. and under	55.00
Rails, random lengths	50.00
Rails, rerolling	65.00
Angles, splice bars	50.00

BIRMINGHAM

No. 1 heavy melting	35.00-36.00
No. 2 heavy melting	30.00-31.00
No. 1 bundles	38.00-39.00
No. 2 bundles	24.00-25.00
No. 1 busheling	40.00-41.00
Cast iron borings	14.00-15.00
Machine shop turnings	24.00-25.00
Short shovel turnings	27.00-28.00
Bar crops and plates	45.00-46.00
Structurals & plates	44.00-45.00
Electric furnace bundles	40.00-41.00
Electric furnace:	
3 ft and under	38.00-39.00
2 ft and under	39.00-40.00

Cast Iron Grades

No. 1 cupola	53.00-54.00
Stove plate	53.00-54.00
Charging box cast	29.00-30.00
Unstripped motor blocks	41.00-42.00
No. 1 wheels	43.00-44.00

Railroad Scrap

No. 1 R.R. heavy melt.	39.00-40.00
Rails, 18 in. and under	*49.00-50.00*
Rails, rerolling	63.00-64.00
Rails, random lengths	*54.00-55.00*
Angles, splice bars	45.00-46.00

PHILADELPHIA

No. 1 heavy melting	45.00
No. 2 heavy melting	39.00
No. 1 bundles	47.00
No. 2 bundles	29.00
No. 1 busheling	47.00
Electric furnace bundles	48.00
Mixed borings, turnings	21.00-22.00†
Short shovel turnings	27.00
Machine shop turnings	24.00
Heavy turnings	35.00†
Structurals & plates	48.00-50.00
Couplers, springs, wheels	*49.00*
Rail crops, 2 ft & under	*64.00-66.00*

Cast Iron Grades

No. 1 cupola	*46.00-47.00*
Heavy breakable cast	48.00
Drop broken machinery	54.00
Malleable	68.00

NEW YORK

(Brokers' buying prices)

No. 1 heavy melting	33.00-34.00
No. 2 heavy melting	30.00-31.00
No. 1 bundles	32.00-33.00
No. 2 bundles	21.00-22.00
Machine shop turnings	*10.00-11.00*
Mixed borings, turnings	*13.00-14.00*
Short shovel turnings	*14.00-15.00*
Low phos. structurals & plates	36.00-37.00

Cast Iron Grades

No. 1 cupola	38.00-39.00
Unstripped motor blocks	25.00-26.00
Heavy breakable	*35.00-36.00*

Stainless Steel

18-8 sheets, clips, solids	195.00-200.00
18-8 borings, turnings	85.00-90.00
410 sheets, clips, solids	55.00-60.00
430 sheets, clips, solids	85.00-90.00

BUFFALO

No. 1 heavy melting	33.00-34.00
No. 2 heavy melting	28.00-29.00
No. 1 bundles	33.00-34.00
No. 2 bundles	23.00-24.00
No. 1 busheling	33.00-34.00
Short shovel turnings	21.00-22.00
Machine shop turnings	17.00-18.00
Cast iron borings	19.00-20.00
Low phos structurals and plate, 2 ft and under	43.00-44.00

Cast Iron Grades (F.o.b. shipping point)

No. 1 cupola	47.00-48.00
No. 1 machinery	51.00-52.00

Railroad Scrap

Rails, random lengths	45.00-46.00
Rails, 3 ft and under	51.00-52.00
Railroad specialties	43.00-44.00

CINCINNATI

(Brokers' buying prices; f.o.b. shipping point)

No. 1 heavy melting	*37.50-38.50*
No. 2 heavy melting	*32.50-33.50*
No. 1 bundles	*37.50-38.50*
No. 2 bundles	*27.00-28.00*
No. 1 busheling	*37.50-38.50*
Machine shop turnings	*19.00-20.00*
Mixed borings, turnings	*19.00-20.00*
Short shovel turnings	*21.00-22.00*
Cast iron borings	*20.00-21.00*
Low phos., 18 in.	*48.00-49.00*

Cast Iron Grades

No. 1 cupola	*48.00-49.00*
Heavy breakable cast	43.00-44.00
Charging box cast	43.00-44.00
Drop broken machinery	*58.00-59.00*

Railroad Scrap

No. 1 R.R. heavy melt.	*42.00-43.00*
Rails, 18 in. and under	*58.00-59.00*
Rails, random lengths	*50.00-51.00*

HOUSTON

(Exporters' buying prices; f.a.s.)

No. 1 heavy melting	39.00
No. 2 heavy melting	35.00-36.00
No. 2 bundles	25.00-26.00

(Brokers' buying prices; f.o.b. cars)

No. 1 heavy melting	34.00†
No. 2 heavy melting	31.00†
No. 1 bundles	34.00
No. 2 bundles	20.00†
Machine shop turnings	17.00
Short shovel turnings	20.00
Low phos. plates & structurals	46.00-47.00

Cast Iron Grades

No. 1 cupola	47.00-48.00
Heavy breakable	35.00
Foundry malleable	43.00-44.00
Unstripped motor blocks	38.50-39.50

Railroad Scrap

No. 1 R.R. heavy melt.	38.00-39.00

BOSTON

(Brokers' buying prices; f.o.b. shipping point)

No. 1 heavy melting	*33.00-34.00*
No. 2 heavy melting	25.50-26.50
No. 1 bundles	*35.00-36.00*
No. 1 busheling	*35.00-36.00*
Machine shop turnings	11.00-12.00
Short shovel turnings	13.00-14.00
No. 1 cast	37.00-38.00
Mixed cupola cast	36.00-37.00
No. 1 machinery cast	38.00-38.50

DETROIT

(Brokers' buying prices; f.o.b. shipping point)

No. 1 heavy melting	36.50-37.50
No. 2 heavy melting	25.00-26.00
No. 1 bundles	39.50-40.50
No. 2 bundles	23.00-24.00
No. 1 busheling	35.50-36.50
Machine shop turnings	16.00-17.00
Mixed borings, turnings	17.00-18.00
Short shovel turnings	18.00-19.00

Cast Iron Grades

No. 1 cupola	46.00-47.00
Stove plate	37.00-38.00
Heavy breakable	36.00-37.00
Unstripped motor blocks	31.00-32.00
Charging box cast	36.00-37.00
Clean auto cast	47.00-48.00

SEATTLE

No. 1 heavy melting	35.00†
No. 2 heavy melting	32.00-33.00
No. 1 bundles	25.00
No. 2 bundles	22.00†
Machine shop turnings	17.00†
Mixed borings, turnings	17.00†
Electric furnace No. 1	38.00†

Cast Iron Grades

No. 1 cupola	34.00†
Heavy breakable cast	28.00†
Unstripped motor blocks	26.00†
Stove plate (f.o.b. plant)	21.00†

LOS ANGELES

No. 1 heavy melting	*40.00*
No. 2 heavy melting	*38.00*
No. 1 bundles	*35.00*
No. 2 bundles	*22.00*
Machine shop turnings	*18.00*
Shovel turnings	*20.00*
Cast iron borings	18.00
Cut structurals and plate 1 ft and under	48.00

Cast Iron Grades (F.o.b. shipping point)

No. 1 cupola	47.00

Railroad Scrap

No. 1 R.R. heavy melt.	39.00

SAN FRANCISCO

No. 1 heavy melting	36.00
No. 2 heavy melting	33.00
No. 1 bundles	33.00
No. 2 bundles	22.00
Machine shop turnings	16.00
Mixed borings, turnings	16.00
Cast iron borings	16.00
Heavy turnings	16.00
Short shovel turnings	16.00
Cut structurals, 3 ft	42.00

Cast Iron Grades

No. 1 cupola	47.00
Charging box cast	34.00
Stove plate	34.00
Heavy breakable cast	28.00
Unstripped motor blocks	31.00
Clean auto cast	40.00
Drop broken machinery	40.00
No. 1 wheels	34.00

HAMILTON, ONT

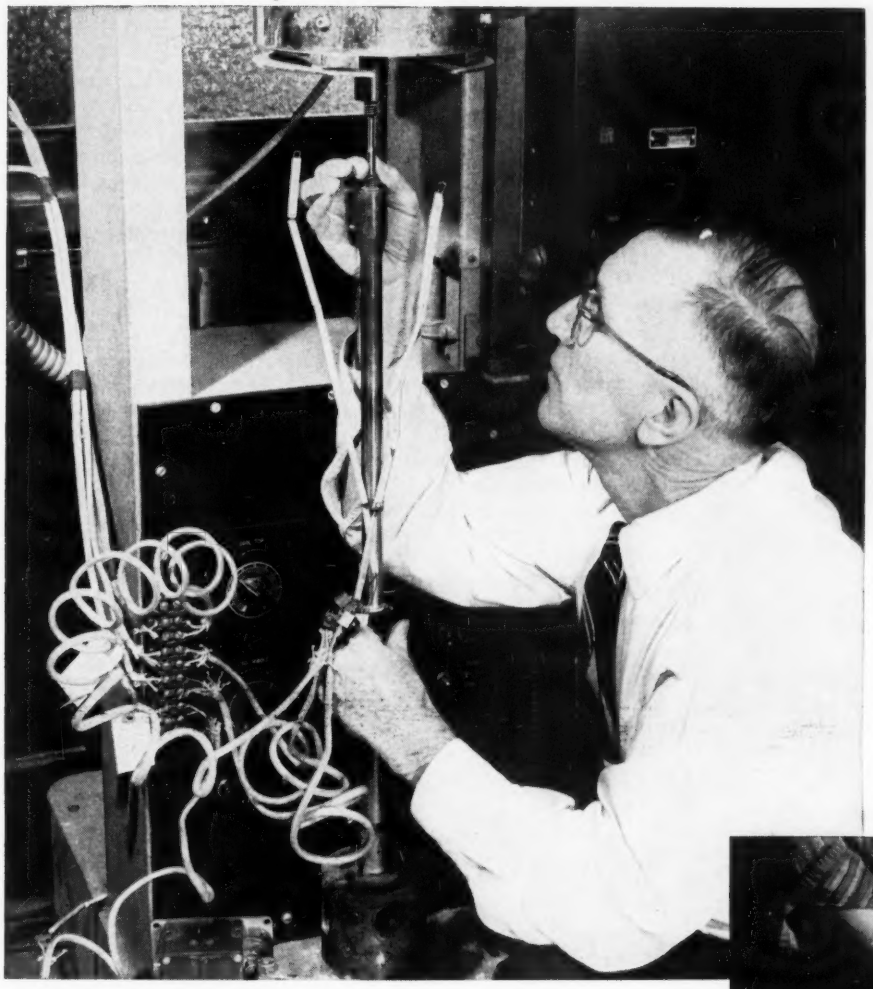
(Brokers' buying prices)

No. 1 heavy melting	32.25
No. 2 heavy melting	28.25
No. 1 bundles	32.25
No. 2 bundles	22.75
Mixed steel scrap	24.25
Mixed borings, turnings	13.00
Busheling, new factory:	
Prepared	32.25
Unprepared	26.25
Short steel turnings	17.00

Cast Iron Grades‡

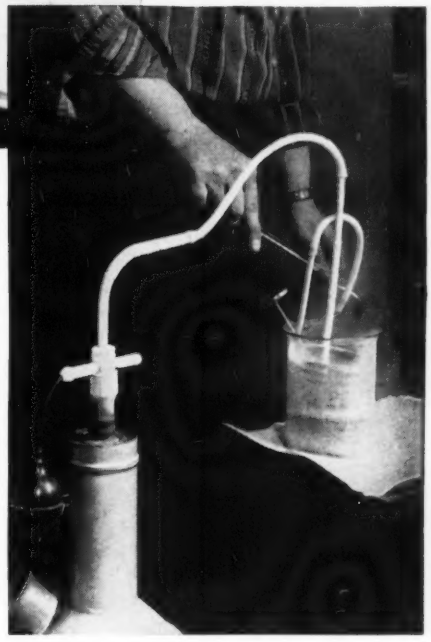
No. 1 machinery cast	46.50-48.00

*Delivered to docks.
†Nominal.
‡F.o.b. Hamilton, Ont.



Physical tests at Standard include those for special properties of steel alloys under extreme variations in temperature. Here, the strength and ductility of steel are being checked for resistance to stress under severe conditions of elevated temperatures over a prolonged period of time.

Charpy impact and transition temperature determinations have recently assumed importance in many applications. Here a steel sample is immersed in liquid nitrogen to determine its susceptibility to fracture at temperatures as low as −300°F.



Quality control—a vital activity at Standard Steel Works

Every conceivable shop and laboratory test required for modern quality control can be performed by Standard's staff of metallurgical technicians. Testing of incoming raw materials; physical property tests of steel and other alloys at temperatures from several hundred degrees below zero up to red heat; gas analysis, ultrasonic, X ray, magnetic particle, fluorescent penetrant and microscopic examination of finished products are routine checks which assure that the finished, delivered product will meet the most rigid specifications. Write Department 2-J for full details.

Standard Steel Works Division

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Brass Mills Diversify

They're going heavily into the rare metals as well as aluminum to get away from full dependency on copper and its alloys. Nonferrous sales in October are fair

Nonferrous Metal Prices, Pages 258 & 259

THE brass mill industry is undergoing a quiet evolution. For some time, major mills have been taking strides to get away from full dependence on copper and its alloys. In fact, the term "brass mill" may be something of a misnomer.

• **Heavy in Aluminum**—The "second" metal in the brass mill industry today is aluminum. Fabrication of sheets, strip, coils, tubing, and extrusions accounts for a big chunk of many companies' business. Several firms have taken on the fabrication of magnesium in recent years.

• **Glamour Metals**—A more recent development is the industry's heavy entry into the field of jet age, high temperature metals. You'll find some making titanium sheets, extrusions, and tubing; zirconium tubing; rhenium strip, rods, and wire. Shapes (mainly extrusions and tubing) are being made of molybdenum, tantalum, columbium, beryllium, and some highly classified alloys.

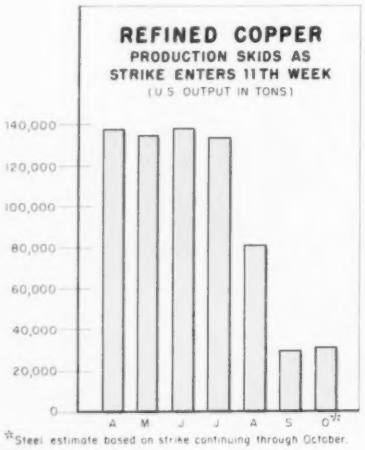
Major customers: Aircraft and missiles, electronics, atomic energy.

Diversification programs are not limited to nonferrous metals. Work is going on in stainless steels, other alloy steels, even plastics.

You'll find the brass mills are adopting more and more fabricating techniques. Examples: Powdered metallurgy, impact extrusion, and permanent mold castings. The mills are generally able to fabricate the newer metals on present equipment, but highly specialized processes are necessary, and such techniques as extrusion, drawing, and vacuum annealing require modification.

Zinc Price Up to 13 Cents

Zinc producers made a move to lure more ore and concentrates to the U. S. when they raised their price a cent a pound to 13 cents on Oct. 21. The equivalent price on the London market is 13.125 cents, and the Canadian quotation has also been moving steadily upward. Domestic business, especially from diecasters, has been firm lately.



*Steel estimate based on strike continuing through October.
Source: Copper Institute

Market Memos

• **In a Nutshell**—There's a hectic scramble for the little copper available. Users have reportedly paid dealers premiums of up to 36 cents a pound. The lead market is quiet.

• **Gaining Momentum**—Aluminum continues to penetrate the auto market. Detroit insiders say that aluminum bumpers will be tested on the Pontiac and several other cars this winter. It's possible the Pontiac people might switch to them in the middle of the '60 model run, especially if steel stocks get tight. In any event, rumor is strong that they will appear on '61 Pontiacs. Also, don't be surprised if you hear of new hot metal contracts being signed by auto companies and the major aluminum producers. So far, Reynolds is the only producer with contracts (two with GM, one with Ford), but Alcoa and Kaiser are "definitely interested."

• **Outlook for Titanium**—Shipments of mill products should hit around 1.4 million lb this quarter. It's a healthy pickup over the estimated third quarter total of 1,066,860 lb. But it's well under the third quarter when orders from aircraftmakers and some hedge buying against the threat of an industry-wide strike resulted in shipments of 2,170,190 lb.

• **Production Notes**—The copper strike has taken its toll on domestic production. September refined output was only 28,847 tons compared with the months just before the strike when production averaged over 135,000 tons monthly (see chart). Domestic mine output of crude copper in September was only 19,166 tons, the lowest since the summer of 1934. Producers' refined stocks dropped to 61,524 tons. At the same time, aluminum production continued to hold at high levels. September primary output reached 168,205 tons, not far off the all-time record of 179,194 tons.

NONFERROUS PRICE RECORD

	Oct. 21 Price	Last Change	Previous Price	Sept. Avg	Aug. Avg	Oct., 1958 Avg
Aluminum	24.70	Aug. 1, 1958	24.00	24.700	24.700	24.700
Copper	30.00–33.00	Aug. 31, 1959	30.00	31.500	30.010	25.058
Lead	12.80	Aug. 24, 1959	11.80	12.800	12.069	12.437
Magnesium	35.25	Aug. 13, 1956	33.75	35.250	35.250	35.250
Nickel	74.00	Dec. 6, 1956	64.50	74.000	74.000	74.000
Tin	101.625	Oct. 21, 1959	101.75	102.440	102.333	96.500
Zinc	13.00	Oct. 21, 1959	12.00	11.360	11.000	10.865

Quotations in cents per pound based on: COPPER, mean of primary and secondary, deld. Conn. Valley; LEAD, common grade, deld. St. Louis; ZINC, prime western, E. St. Louis; TIN, Straits, deld. New York; NICKEL, electrolytic cathodes, 99.9%, base size at refinery, unpacked; ALUMINUM, primary pig, 99.5+%, f.o.b. customer custody; MAGNESIUM, pig 99.8%, Velasco, Tex.

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To make every pound of strip, rod and wire the way we would want it, if we were buying it

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means Brass at its best

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Nonferrous Metals

Cents per pound, carlots except as otherwise noted.

PRIMARY METALS AND ALLOYS

Aluminum: 99.5%, pigs, 24.70; ingots, 26.80, 30,000 lb or more, f.o.b. customer custody.

Aluminum Alloy: No. 13, 28.60; No. 43, 28.40; No. 195, 29.40; No. 214, 30.20; No. 356, 28.60; 30 or 40 lb ingots.

Antimony: R.M.M. brand, 99.5%, 29.00; Lone Star brand, 29.50, f.o.b. Laredo, Tex., in bulk. Foreign brands, 99.5%, 24.50-25.00, New York, duty paid, 10,000 lb or more.

Beryllium: 97% lump or beads, $71.50 per lb, f.o.b. Cleveland or Reading, Pa.

Beryllium Aluminum: 5% Be, $74.75 per lb of contained Be, with balance as Al at market price, f.o.b. shipping point.

Beryllium Copper: 3.75-4.75% Be, $43 per lb of contained Be, with balance as Cu at market price on shipment date, f.o.b. shipping point.

Bismuth: $2.25 per lb, ton lots.

Cadmium: Sticks and bars, $1.40 per lb deld.

Cobalt: 99+%, $1.75 per lb for 500-lb keg, $1.77 per lb for 100 lb case; $1.82 per lb under 100 lb.

Columbium: Powder, $55-85 per lb nom.

Copper: Electrolytic, 30.00-31.50 deld.; custom smelters, 33.00; lake, 31.50 deld.; fire refined, 29.75-31.25 deld.

Germanium: First reduction, less than 1 kg, 38.30 per gram; 1-10 kg, 33.30 per gram; 10 kg or more, 31.30 per gram; intrinsic grade, 33.30-35.30 per gram.

Gold: U. S. Treasury, $35 per oz.

Indium: 99.9%, $2.25 per troy oz.

Iridium: $75-80 per troy oz nom.

Lead: Common, 12.80; chemical, 12.90; corroding, 12.90, St. Louis. New York basis, add 0.30.

Lithium: 1 lb or 2 lb ingots, less than 50 lb, $11 per lb, f.o.b. Minneapolis; 50-99 lb, $10; 100-499 lb, $9.50; 500 lb or more, $9 per lb, delivered.

Magnesium: Pig, 35.25; ingot, 36.00 f.o.b. Velasco, Tex.; 12 in. sticks, 59.00 f.o.b. Madison, Ill.

Magnesium Alloys: AZ91A (diecasting), 40.75 deld.; AZ63A, AZ92A, AZ91C (sand casting), 40.75, f.o.b. Velasco, Tex.

Mercury: Open market, spot, New York, $224-226 per 75 lb flask.

Molybdenum: Unalloyed forging billets, 4.125-7.0 in. diam., 50-4999 lb, $8.15-11.50 per lb, depending on quantity; 5000 lb or more, $8 per lb, f.o.b. Coldwater, Mich.

Nickel: Electrolytic cathodes, sheets (4 x 4 in. and larger), unpacked, 74.00; 10-lb pigs, unpacked, 78.25; "XX" nickel shot, 79.50; "F" nickel shot for addition to cast iron, 74.50; "F" nickel, 5 lb ingots in kegs for addition to cast iron, 75.50. Prices f.o.b. Port Colborne, Ont., including import duty. New York basis, add 1.01. Nickel oxide sinter at Buffalo, New York, or other established U. S. ports of entry, contained nickel, 69.60.

Osmium: $70-100 per troy oz nom.

Palladium: $18-20 per troy oz.

Platinum: $77-80 per troy oz from refineries.

Radium: $16-21.50 per mg radium content, depending on quantity.

Rhodium: $122-125 per troy oz.

Ruthenium: $55-60 per troy oz.

Selenium: $7.00 per lb, commercial grade.

Silver: Open market, 91.375 per troy oz.

Sodium: Solid pack, c.l., 19.50; l.c.l., 20.00; brick, c.l., 21.00; l.c.l., 21.50; tank car, 17.00.

Tantalum: Melting stock, $35 per lb; rod, $60 per lb nom.; sheet, $55 per lb nom.

Tellurium: $2.50 per lb.

Thallium: $7.50 per lb.

Tin: Straits, N. Y., spot and prompt, 102.375.

Titanium: Sponge, 99.3 + % grade A-1, ductile (0.3% Fe max.), $1.60 per lb; grade A-2 (0.5% Fe max.), $1.50 per lb.

Tungsten: Powder, 98.8%, carbon reduced, 1000-lb lots, $2.75-2.90 per lb nom., f.o.b. shipping point; less than 1000 lb, add 15.00; 99+% hydrogen reduced, $3.00-3.80.

Zinc: Prime western, 13.00; brass special, 13.25; intermediate, 13.50, East St. Louis, freight allowed over 0.50 per lb. New York basis, add 0.50. High grade, 14.25; special high grade, 14.50 deld. Diecasting alloy ingot No. 3, 16.25; No. 2, 16.75; No. 5, 16.50 deld.

Zirconium: Reactor grade sponge, 100 lb or less, $8 per lb; 100-500 lb, $7.00 per lb; over 500 lb, $6.50 per lb.
(Note: Chromium, manganese, and silicon metals are listed in ferroalloy section.)

SECONDARY METALS AND ALLOYS

Aluminum Ingot: Piston alloys, 26.00-27.75; No. 12 foundry alloy (No. 2 grade), 23.75-24.00; 5% silicon alloy, 0.60 Cu max., 25.50; 13 alloy, 0.60 Cu max., 25.00; 195 alloy, 26.75-27.00; 108 alloy, 24.25-24.50. Steel deoxidizing grades, notch bars, granulated or shot: Grade 1, 24.50; grade 2, 23.25; grade 3, 22.25; grade 4, 21.50.

Brass Ingot: Red brass, No. 115, 29.25; tin bronze, No. 225, 39.75; No. 245, 33.50; high-leaded tin bronze, No. 305, 33.50; No. 1 yellow, No. 405, 23.75; manganese bronze, No. 421, 26.75.

Magnesium Alloy Ingot: AZ63A, 37.50; AZ91B, 37.50; AZ91C, 41.25; AZ92A, 37.50.

NONFERROUS PRODUCTS

BERYLLIUM COPPER

(Base prices per lb, plus mill extras, 2000 to 5000 lb; nom. 1.9% Be alloy.) Strip, $1.91, f.o.b. Temple, Pa., or Reading, Pa.; rod, bar, wire, $1.89, f.o.b. Temple, Pa.

COPPER WIRE

Bare, soft, f.o.b. eastern mills, 20,000-lb lots, 36.85; l.c.l., 37.48. Weatherproof, 20,000-lb lots, 37.42; l.c.l., 38.17.

LEAD

(Prices to jobbers, f.o.b. Buffalo, Cleveland, Pittsburgh.) Sheets, full rolls, 140 sq ft or more, $18.50 per cwt; pipe, full coils, $18.50 per cwt; traps and bends, list prices plus 30%.

TITANIUM

(Prices per lb, 10,000 lb and over, f.o.b. mill.) Sheet and strip, $7.25-17.00; sheared mill plate, $5.25-10.00; wire, $5.75-10.00; forging billets, $3.55-5.75; hot-rolled and forged bars, $4.25-7.50.

ZINC

(Prices per lb, c.l., f.o.b. mill.) Sheets, 26.00; ribbon zinc in coils, 21.50; plates, 20.00.

ZIRCONIUM

Plate, $12.50-19.20; H.R. strip, $12.50-22.90; C.R. strip, $15.90-31.25; forged or H.R. bars, $11.00-17.40.

NICKEL, MONEL, INCONEL

	"A" Nickel	Monel	Inconel
Sheets, C.R.	138	120	138
Strip, C.R.	124	108	138
Plate, H.R.	130	110	126
Rod, Shapes, H.R.	107	89	109
Seamless Tubes	157	129	200

ALUMINUM

Sheets: 1100, 3003, and 5005 mill finish (30,000 lb base; freight allowed).

Thickness Range Inches	Flat Sheet	Coiled Sheet
0.250-0.136	42.80-47.30	.....
0.136-0.096	43.20-48.30	.....
0.126-0.103	.....	39.20-39.80
0.096-0.077	43.80-50.00	39.30-40.00
0.077-0.068	44.30-52.20	.....
0.077-0.061	.....	39.50-40.70
0.068-0.061	44.30-52.20	.....
0.061-0.048	44.90-54.40	40.10-41.80
0.048-0.038	45.40-57.10	40.60-43.20
0.038-0.030	45.70-62.00	41.00-45.70
0.030-0.024	46.20-53.70	41.30-45.70
0.024-0.019	46.90-56.80	42.40-44.10
0.019-0.017	47.70-54.10	43.00-44.70
0.017-0.015	48.60-55.00	43.80-45.50
0.015-0.014	46.60	44.80-46.50
0.014-0.012	50.80	45.50
0.012-0.011	51.00	46.70
0.011-0.0095	53.50	48.10
0.0095-0.0085	54.60	49.60
0.0085-0.0075	56.20	50.85
0.0075-0.007	57.70	52.30
0.007-0.006	59.30	53.70

MAGNESIUM

Sheet and Plate: AZ31B standard grade, 0.32 in., 103.10; .081 in., 77.90; .125 in., 70.40; .188 in., 69.00; .250-2.0 in., 67.90. AZ31B spec. grades, .032 in., 171.30; .081 in., 108.80; .125 in., 98.10; .188 in., 95.70; .250-2.00 in., 93.30. Tread plate, 60-192 in. lengths, 24-72 in. widths; .125 in., 74.90; .188 in., 71.70-72.10; .25-.75 in., 70.60-71.60. Tooling plate, 0.25-3.0 in., 73.00.

Extruded Solid Shapes:

Factor	Com. Grade (AZ31C)	Spec. Grade (AZ31B)
6-8	65.30-67.60	84.60-87.40
12-14	65.30-67.60	85.70-88.00
24-26	66.10-75.30	90.60-91.30
36-38	66.10-75.30	104.20-105.30

NONFERROUS SCRAP

DEALERS' BUYING PRICES

Copper and Brass: No. 1 heavy copper and wire, 24.50-25.00; No. 2 heavy copper and wire, 22.00-22.50; light copper, 20.25-20.75; No. 1 composition red brass, 18.50-18.75; No. 1 composition turnings, 17.50-17.75; new brass clippings, 15.50-16.00; light brass, 12.00-12.50; heavy yellow brass, 13.00-13.50; new brass rod ends, 13.50-14.00; auto radiators, unsweated, 14.00-14.50; cocks and faucets, 14.75-15.25; brass pipe, 15.00-15.50.

Lead: Soft scrap lead, 8.50-9.00; battery plates, 4.25-4.50; linotype and stereotype, 10.00-10.50; electrotype, 8.25-8.75; mixed babbitt, 9.25-9.75.

Monel: Clippings, 30.00-32.00; old sheets 26.00-28.00; turnings, 20.00-22.00; rods, 30.00-32.00.

Nickel: Sheets and clips, 52.00-54.00; rolled anodes, 52.00-54.00; turnings, 39.00-40.00; rod ends, 52.00-54.00.

Zinc: Old zinc, 3.50-3.75; new diecast scrap, 3.25-3.50; old diecast scrap, 2.00-2.25.

Aluminum: Old castings and sheets, 11.00-11.50; clean borings and turnings, 7.00-7.50; segregated low copper clips, 15.00-15.50; segregated high copper clips, 14.00-14.50; mixed low copper clips, 14.50-15.00; mixed high copper clips, 12.50-13.00.

(Cents per pound, Chicago)

Aluminum: Old castings and sheets, 12.25-12.75; clean borings and turnings, 10.00-10.50; segregated low copper clips, 16.75-17.25; segregated high copper clips, 16.00-16.50; mixed low copper clips, 16.00-16.50; mixed high copper clips, 15.75-16.25.

(Cents per pound, Cleveland)

Aluminum: Old castings and sheets, 11.50-11.75; clean borings and turnings, 10.50-11.00; segregated low copper clips, 15.75-16.25; segregated high copper clips, 14.75-15.25; mixed low copper clips, 15.25-15.75; mixed high copper clips, 14.25-14.75.

REFINERS' BUYING PRICES

(Cents per pound, carlots, delivered refinery)

Beryllium Copper: Heavy scrap, 0.020-in. and heavier, not less than 1.5% Be, 57.50; light scrap, 52.50; turnings and borings, 37.50.

Copper and Brass: No. 1 heavy copper and wire, 28.50; No. 2 heavy copper and wire, 25.00; light copper 23.00; refinery brass (60% copper) dry copper content, 24.50.

INGOTMAKERS' BUYING PRICES

Copper and Brass: No. 1 heavy copper and wire, 28.50; No. 2 heavy copper and wire, 25.00; light copper, 23.00; No. 1 composition borings, 22.00; No. 1 composition solids, 22.50; heavy yellow brass solids, 16.00; yellow brass turnings, 15.00; radiators, 17.25.

BRASS MILL PRICES

	MILL PRODUCTS a				SCRAP ALLOWANCES e (Based on copper at 31.50c)		
	Sheets, Strip, Plate	Rod	Wire	Seamless Tubes	Clean Heavy	Rod Ends	Clean Turnings
Copper	54.63b	52.86c	....	55.82	27.500	27.500	26.750
Yellow Brass	48.65	34.21d	49.19	52.06	21.000	20.125	19.125
Low Brass, 80%	51.48	51.42	52.02	54.79	23.500	23.250	22.750
Red Brass, 85%	52.48	52.42	53.02	55.79	24.375	24.125	23.625
Com. Bronze, 90%	54.02	53.96	54.56	57.08	25.250	25.000	24.500
Manganese Bronze	57.00	50.68	61.12	....	19.750	19.500	18.875
Muntz Metal	51.35	46.66	....	....	19.875	19.625	19.125
Naval Brass	53.29	47.10	59.85	56.70	19.625	19.375	18.875
Silicon Bronze	60.67	59.86	60.21	78.35	27.000	26.750	26.000
Nickel Silver, 10%	64.13	66.46	66.46	....	25.875	25.625	12.812
Phos. Bronze	75.34	75.84	75.84	77.02	28.625	28.375	27.375

a. Cents per lb, f.o.b. mill; freight allowed on 50 lb or more. b. Hot-rolled. c. Cold-drawn. d. Free cutting. e. Prices in cents per lb for less than 20,000 lb, f.o.b. shipping point. On lots over 20,000 lb at one time, of any or all kinds of scrap, add 1 cent per lb.

ANOTHER LARGE AUCTION

Thursday, Nov. 5, 1959
9:00 A.M. (CST)
NOWATA PIPE & SUPPLY CO.
Nowata, Okla.

GOING OUT OF BUSINESS

Registration Starts at 8
Inspection Beginning Nov. 2

Nowata Pipe and Supply Co. is quitting business and has commissioned Wayne Cook Associates, Inc. to sell all of their equipment, supplies and accessories at public auction to the highest bidder.

ITEMS TO BE SOLD INCLUDE:

More than 200,000 feet of new and used pipe in sizes from 1 in. to 30 in.
200 Tons of new pipe nipples, ⅛ in. to 4 in. All threads to 12 in. Black & galvanized.
60,000 ft of ⅝ in. sucker rods
60 Tons of new and used structural steel consisting of I beams, channel, angle, round and flat.
200 Tons of scrap metal.
50 Tons of assorted steel and cast valves, screw and flange.
50 Tons of new and used pipe couplings.
8 Tons of cold rolled rounds up to 4½ in. O.D.
40 Tons new sheet steel, ⅛ in. and 3/16 in.
1,600 H.P. in electric motors from 1/4-75 H.P., mostly 220/440, 3 phase, all operating cond.
15 Tons of electric wire, 2 to 4 conductor, 18 to 12 ga.
100 Tons of assorted cold drawn seamless mech. tubing, 2 in.—12-¾ in. O.D.
PIPE MACHINES—2 in., 6 in., 7 in., 8 in., and 10 in.
AIR COMPRESSORS AND WELDERS incl. 165 and 225 cfm A.C., 2 Lincoln 200 amp. gas driven welders, 3 elec. 200 amp. welders.
1 set of 8 ft. Pyramid steel rolls; Hydraulic Pipe Straightener; 2 Pipe Cleaning Machines; 1 Rolling Cutting Machine.
1 Lot of Cable Tools incl. stems, jars and fishing tools.
TRUCKS AND TRAILERS incl. CARS and PICK-UPS—1959 F6; 4 Chev. 1958 6400s; 1956 and 1957 Chev. 6400; 1958 Olds Super 88 Holiday with power and air; 3 single axle floats, 3 single axle pole trailers.
DIRT AND HEAVY EQUIPMENT incl. Bantam 1/3-yd. Backhoe on 6x6 GMC; Int. 200 Utility with Henry Backhoe and Loader; TD9 with Hyd. Blade; 2 M4 Prime Movers with Cont. 190 engs.
Also 30 ft. x 80 ft. and 24 ft. x 70 ft. metal buildings and 200 lb. Frigidaire Ice Maker.
A large amount of office equipment and many, many other items too numerous to list.

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E. I. DU PONT DE NEMOURS & COMPANY

New opportunities in the growing and important field of refractory metals are now available with du Pont at a new facility to be located in Baltimore, Maryland. A major expansion in alloy development, metal manufacture and mill product processing techniques is being conducted. Two supervisory positions are open for men who have from 5 to 10 years' experience in metals processing.

Production Supervisor—Rolled Products

The position requires the daily supervision of the rolling and finishing areas. The rolling area consists of multi-purpose rolling facilities, unique in design, and capable of very diversified operations. Both hot and cold rolling of sheet, bars and coils of refractory metals will be involved. Experience in finishing, heat-treating and inspection is essential.

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The position requires previous experience in consumable electrode-cold mold-arc melting operations. In addition, thorough knowledge of electrode preparation and the behavior of refractory metals on melting and solidification is required.

Trained personnel in physical and mechanical metallurgy or those with equivalent experience are needed for these supervisory openings. Please forward resume, including details of education, experience and salary expected to Mr. A. F. Hartford, Employee Relations Department, E. I. du Pont de Nemours & Company, Wilmington, Delaware. Replies held confidential.

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He must be experienced in all phases of structural steel fabrication methods and costs—

He must be able to handle men—

He must have sterling references as to business ability, stability and character.

Preferably he should have a college education and with an unusual record of job accomplishments.

If you are this man—the only way we will know is to hear from you. Make your resume as complete as possible, including age and pertinent facts which you feel would give you an "edge" over other applicants.

Excellent salary.

Write in strict confidence to **Box 796, STEEL, Penton Bldg., Cleveland 13, Ohio.**

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11" to 12½"	Dia.	.085 to .095

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22 ga., 24 ga. and 26 ga. New, unstained. Up to 80 tons. All or part. Give sizes, quantities, price and location. Can also use 4", 5", 6", 8" and 10" structural steel channels; 7", 8", 10", 14" I-beams.

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WEST SACRAMENTO, CALIF.

PRESSES WANTED

One press or entire stamping or forging plant. Write or phone in confidence.

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CLASSIFIED

Help Wanted

SALESMEN WANTED—Several aggressive men with college training and several years experience selling LP-Gas equipment and/or selling to machinery manufacturers—various locations. Scaife Company, Pittsburgh District, Oakmont, Pennsylvania.

WANTED:

SECOND-HAND STEEL BUILDING SUITABLE FOR TWIN BEECH-CRAFT HANGAR

Will dismantle and erect on our property. Please advise size and location.

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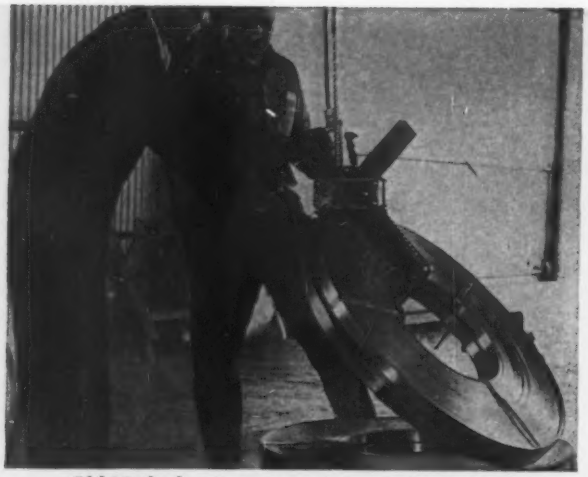
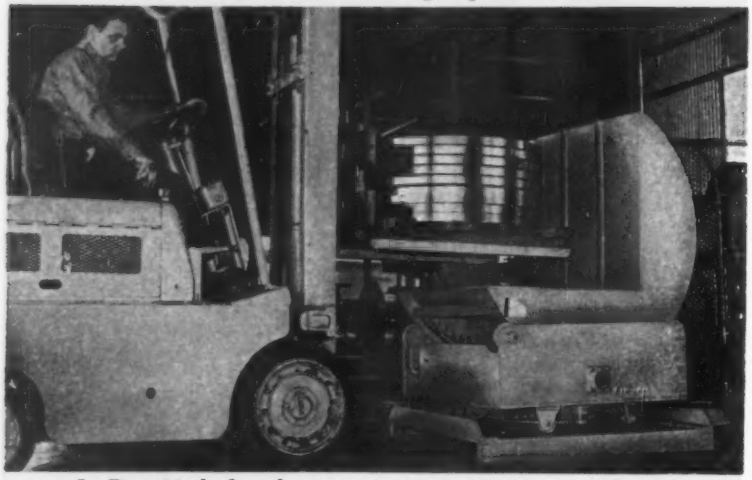


Old Method – time consuming, requires two men



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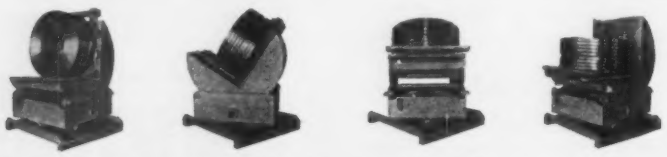
Producers or users of coiled materials can now palletize coils weighing from 3000 to 40,000 pounds in 14-40 seconds with the completely automatic La Deau TURNOVER CRADLE. You save up to 400% in storage efficiency, 600% in labor efficiency, and eliminate elongated coils and dangerous band breakage. If you handle *only a carload of coiled materials per month*, you can pay for a TURNOVER CRADLE in about a year, with labor savings alone. Reason: the fully portable Cradle lets one man handle as much material in one hour as two men usually handle in three hours!



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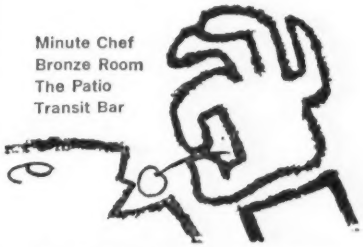
things are popping at

SHERATON-CLEVELAND HOTEL

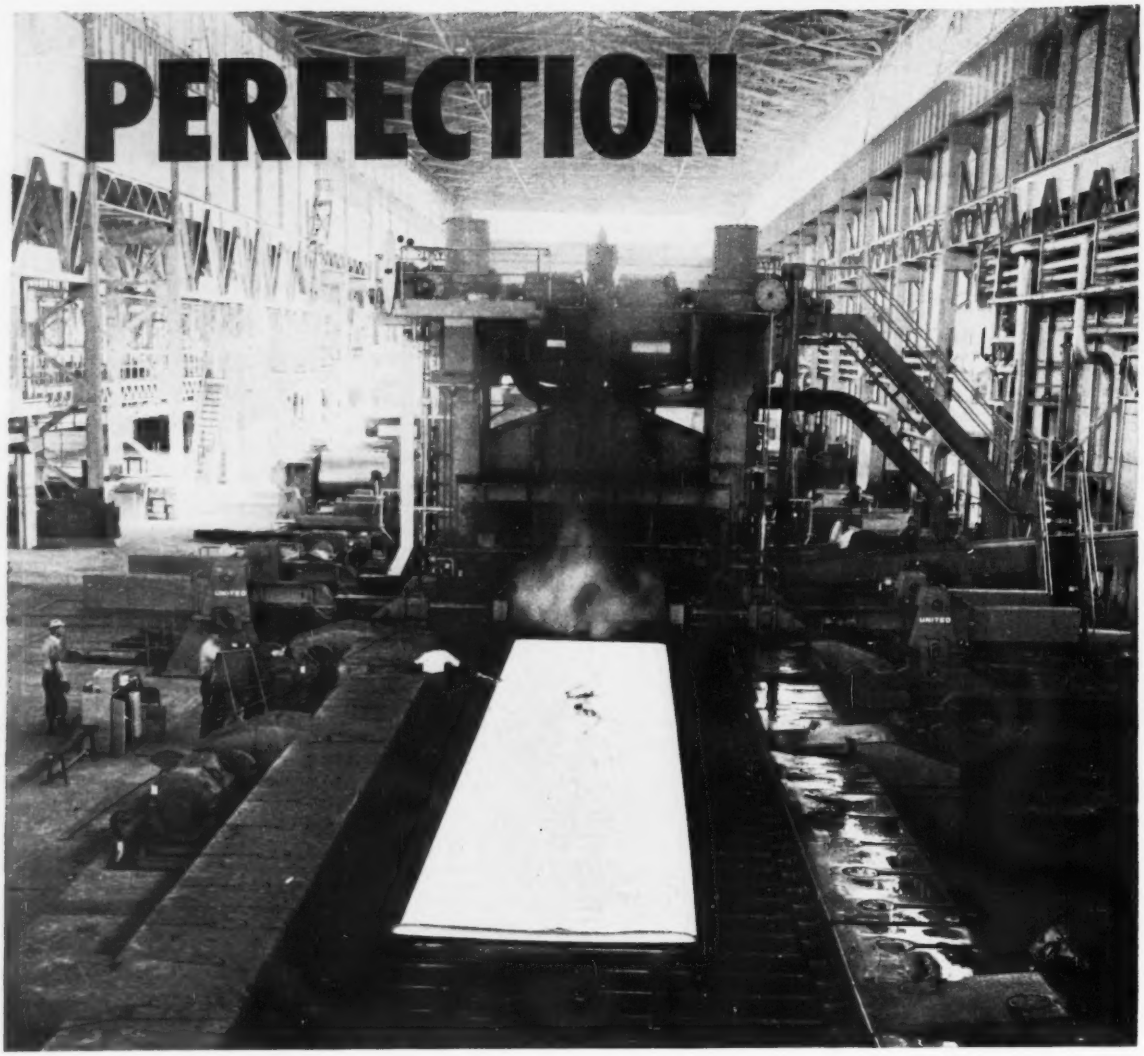
- 100% air-conditioning of all guest rooms, restaurants, and function rooms.
- Major room redecoration (both guest and function rooms).
- Free radio and television in all guest rooms.
- Interior and exterior modernization.
- Now "Reservatron" — World's first electronic hotel reservations service reserves and confirms your reservations in a split second in Sheraton cities from coast to coast in the USA, Canada and Hawaii.
- Many new convention innovations and banquet facilities.
- Modern new Presidential Suite.
- New stores and guest services.
- New charcoal grill specializing in steaks, ribs and chops.
- New popular priced coffee shop "The Minute Chef"—for busy people.
- And many more new developments.

SHERATON-CLEVELAND HOTEL

meal time
night time
any time



Public Square • Cleveland, Ohio
TOwer 1-8000



Fuji's modern 160" plate mill

From Pig to Finished Products

FUJI IRON & STEEL CO., LTD., a giant among Asia's steelmakers, has made vast strides towards achievement of perfection in all phases of iron and steel production. FUJI STEEL products can be depended upon because rigid control is maintained over quality at all essential points.

FUJI IRON & STEEL CO., LTD.

Cable: STEELFUJI TOKYO

Head Office
Tokyo, Japan

New York Office
Room 805, 52 Broadway
New York 4, N.Y.
United States of America

European Office
Graf-Adolf Str. 86/88
Dusseldorf
Germany

ROTOBLAST CUTS CLEANING TIME 42%

Pangborn Rotoblast reduces cleaning time from 12-15 minutes per 2,000 lb. load to 7 minutes at Ingersoll-Rand

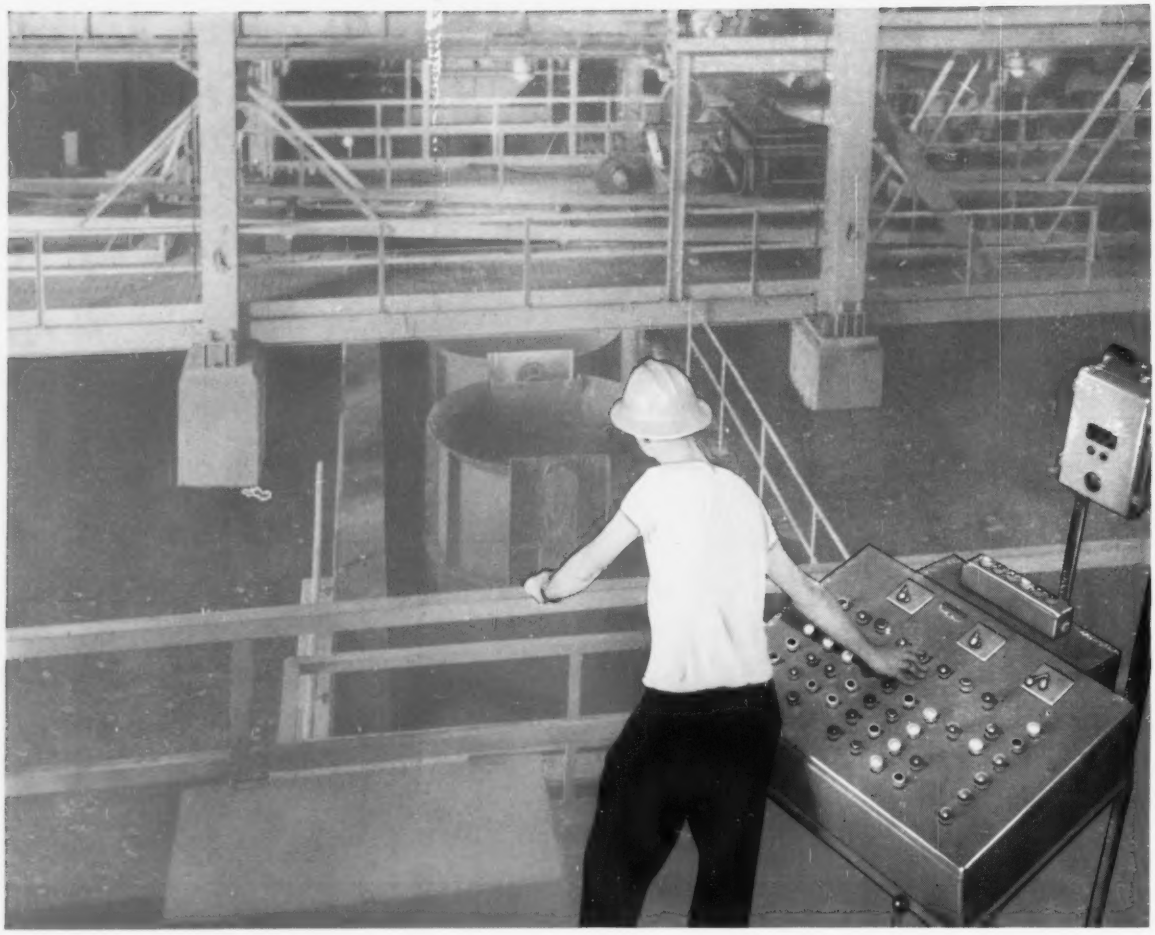
At Ingersoll-Rand Co., Painted Post, N. Y., blast cleaning loads weigh 2,000 lbs., include castings up to 300 lbs. each. To handle these loads efficiently, Ingersoll-Rand replaced its old blast cleaning barrel with a new Pangborn Rotoblast Barrel . . . and benefited *three* ways!

Cleaning quality is "incomparably better." Maintenance time and costs have been drastically cut. (For example, wheel vanes previously lasted 12 to 15 blast hours, now last 70 blast hours.) And cleaning time per load has been reduced from 12-15 minutes to only 7 minutes! Cleaning production now exceeds 10,000 lbs. per hour, cutting 7½-hour days to 3 and 4-hour days in the cleaning department.

For full details on how Pangborn Rotoblast can save you money, write: PANGBORN CORPORATION, 1600 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Blast Cleaning and Dust Control Equipment —Rotoblast Steel Shot and Grit.*®

Pangborn

Cleans it fast with ROTOBLAST®



ON THE CHARGING LINE AT ACME STEEL

World's largest Cupolas are equipped with Cutler-Hammer Control

To satisfy the 50 tons per hour appetite of Acme Steel's new giant hot blast cupolas, Cutler-Hammer engineered the fully automatic charging control system. Another industry "first", this amazing system directs the synchronized operations of the twin charging buckets between the stock area and cupola top from a single control station. With push-button control the scrap iron, coke, and stone are weighed, logged, and dumped into a waiting charging bucket. The bucket is automatically transferred to the special hooded charging crane which carries the load to the cupola top. Here the motions of the charging crane are integrated with those of the cupola's pressure cap and gates to permit discharging of the bucket onto the burden without losing top pressure.

The development of this *new* and *different* charging system and its control is another typical example of mill engineers, equipment manufacturers, and Cutler-Hammer engineers working together to solve *new* and *different* mill problems. Remember this when you are planning new facilities or modernizing existing machines and processes. Cutler-Hammer's 68 years of Mill Control experience can prove to be a valuable asset to you during the early planning stages. Your inquiry will receive prompt attention without obligation. Dept. U213, Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

Look to Cutler-Hammer Mill Experience . . . as broad as it is long

CUTLER-HAMMER CONTROL C-H

CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wis. • *Division:* **Airborne Instruments Laboratory.** • *Subsidiary:* **Cutler-Hammer International, C. A.**

Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.; Intercontinental Electronics Corporation.